Smart Circular Cities: Governing the Relationality, Spatiality, and Digitality in the Promotion of Circular Economy in an Urban Region

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Abstract: This article discusses the governance of a smart-green transition in an urban region. The focus is on how the modes of public governance relate to relationality, spatiality, and digitality, which are of vital importance in determining the success of the transition in question. The empirical inquiry is based on observations of the case of the Tampere urban region in Finland, which exemplifies such governance efforts in the Nordic welfare society context. The discussion shows that the relationality in the given context is fragmentary, dominated by persuasive network governance and soft means of exerting pressure. Municipalities assume many roles in CE governance, which matches their urge to utilize different institutional logics from hierarchies to markets and networks. Rather than a genuine authority, municipalities emerge as facilitators and enablers. Spatiality is highlighted in the formation of designated areas that serve circularity and also provide brand benefits, as shown by the eco-industrial park in the city of Nokia. Digitalization is an underdeveloped area in the circular economy agenda vis-à-vis its assumed potential. Its relevance has been identified by institutional players in the urban-regional governance field, but its realization seems to require both nationally coordinated actions and local solutions that compensate for the lack of a critical mass of developers and users in the circular economy ecosystem. Lastly, regarding urban governance, the parallel utilization of different modes of governance forms a complex setting, in which increasingly sophisticated forms of hybrid governance are emerging. Most notably, in the case of the Tampere urban region, the promotion of a circular economy by intermediaries is supplemented by novel dynamic assemblages that utilize different institutional logics within loosely governed processes that aim at integrating a circular economy into business models and urban development.

Keywords: circular economy; circularity; circular city; smart circular city; urban metabolism; dissipative structure; urban governance; public governance; relationality; spatiality; eco-industrial park; digitality; smart city; tampere; Nokia; Finland

1. Introduction

A circular economy (CE) has an important role in the global sustainability agenda. The Paris Climate Conference (COP21), held on 12 December 2015, was one of the key drivers behind the rise of the CE agenda [1,2]. The promise of this circularity lies in the circularity gap that is waiting to be filled. The current economy is estimated to be only some 8.6% circular. The Circularity Gap Report 2021 states that we need roughly double the current figure to reach the satisfactory level regarding the overall climate goals [3,4]. In addition to contributing to the reduction in greenhouse gas emissions, a CE ensures that waste disposal is reduced considerably, nutrients are returned to the soil, and raw materials are saved considerably [5].

Circularity is in essence both an environmental and economic issue as it discusses the material side of sustainable production and consumption [6]. Recently, the importance of governance and organizational issues have been taken on by the CE agenda, as responses to ecological concerns are conditioned by the organizational capacities and governance

structures at different institutional levels. We may identify a knowledge gap here, for CE research has been traditionally dominated by a business-focused narrative for competitive advantage, which has raised legitimate concerns of its relevance to a broader urban sustainability agenda [7]. Moreover, as the agenda has been built largely at the intersection of environmental and economic concerns, urban governance issues have been neglected until recently. In particular, the integrative view of urban governance has rarely been addressed, even if it has a crucial role in understanding the premises of urban CE policies.

Another critical issue is how urban governance relates to its local context. As urban communities are large high-density settlements with a critical role in every society at the intersection of production and consumption, they have attracted increasing attention in the CE discourse [8]. This interest is due to cities' relevance on both the problem and opportunity sides of the CE. Cities are estimated to be responsible for about 72% of global greenhouse gas emissions, which has been rising in relative terms over the few past decades [9,10]. A circular economy has the potential to effectively narrow the emissions gap and contribute to various aspects of the sustainability agenda and, in economic terms, to create innovations, business opportunities, and jobs [3]. This explains the interest in the role of city governments in the design and implementation of CE policies, which as a holistic place-based idea, is referred to as a circular city (CC).

The introduction of the CE to urban development happened in the developed world at the time when smart cities had become a popular concept as a reflection of the profound technological changes taking place. The connection between smartness and sustainability highlights the intersection of these two trends [11–13]. However, there is a lack of conceptual clarity in how sustainability relates to smart city development [14–19]. In their analysis of global smart city discourse, Joss and others [20] conclude that, surprisingly, the environment and ecological sustainability are generally afforded a rather marginal role. This aligns with the fact that smart city frameworks lack environmental indicators [21]. There is thus an obvious knowledge gap here, which implies that we need a better understanding of how smart city initiatives and urban technologies relate to sustainability and the related political, economic, and social processes [22,23]. Research is even more scarce in the area of smart urban circularity. There are a few publications that address the smart-green interplay in narrowly defined application domains, such as transport, energy, water supply, material use, or manufacturing, but the broader picture of the nature of the urban smart-green interplay, not to speak of transitioning to a smart CC or smart urban CE, is lacking. Urban smartness and circularity have overlapping areas, but their dynamics and connections are still insufficiently analyzed [18,24]. This urges us to ask how digital technologies—artificial intelligence, Internet of Things, cloud computing, Big Data, and different kinds of smart systems—that transform entire city ecosystems can contribute to an urban CE.

The governance of the smart transition to urban circularity discussed above has not been systematically integrated into the analysis of urban circularity and the related local CE policies. How are the various constitutive aspects of the concept of 'urban,' which refers to people who live permanently in a densely-populated area supported by urban infrastructures, taken into account in the conceptualization of CC or urban CE? The connections of such conceptual categories have been addressed separately, as with the connection between smartness and sustainability [14,16–18] or the spatial dimension of a smart city policy [25]. Interestingly, the spatial dimension of the urban CE is explicitly addressed only rarely, even if the location of circular activities, such as the recycling, reuse, or storage of materials, is crucial for such activities [26]. More importantly, while the research on the urban governance of the CE has been slowly emerging [7,27–31], it has not been systematically connected with the critical urban functions and factors that condition the design and implementation of CE policies. Such elements are recognized as interrelated aspects of urban circularity, which require an integrated view in order to be properly understood [26]. Such a requirement is rarely met in the current literature. To summarize, we can pinpoint several knowledge gaps, which cluster around the issue of how urban

governance within the CE policy framework is conditioned by and affects such critical aspects of urbanity as urban metabolism flows, people, space, and technology.

The aim of this article is to make sense of the smart-green transition by outlining the ontological layers of urban circularity with a focus on three critical aspects of the development of a circular city, those of social relations, spatial dimension, and digitalization, and finally to assess how the modes of urban governance affect the responses to urban CE challenges with regard to these three dimensions. The following research question guides the inquiry of this article: how do the modes of governance relate to the social, spatial, and digital aspects of the smart-green transition of cities in the advanced welfare society context?

The Interplay of the three abovementioned aspects of urban smart-green transition is connected with the physical layer of circular city ontology, depicted as flows and dissipative structures within the urban metabolism framework. In the purpose of shedding light on the relevant agency that reflects the teleological side of urban CE development, this discussion highlights the role of the city government as the primus inter pares in local governance, with varying levels of commitment to and engagement in the promotion of urban circularity, that is generally assumed to contribute to the attainment of a sustainable urban future. In this article, the real-life case is the Tampere urban region, Finland. The main function of the case is to exemplify the theoretically constructed view of how the modes of urban governance relate to the abovementioned conditioning factors of the urban CE policy in the Nordic welfare society context.

The contribution of this article can be highlighted with the following three points. This article will outline an integrative view of urban circularity, show how the modes of governance relate to critical conditioning aspects of urban circularity, and provide an empirical exemplification of the relationality, spatiality, and digitality in the case of the Tampere urban region, Finland.

This article is structured as follows. The introductory section is followed by a theoretical discussion that revolves around the ideas of the city as a dissipative structure and urban metabolism, and continues to the conceptualization of an urban circular economy and its three conditioning aspects—those of relationality, spatiality, and digitality. The last element of the framework is urban governance and, more precisely, the connection between the modes of governance and urban smart-green transition. The next section discusses the methodological underpinnings of this article, followed by an empirical analysis of the case of municipalities in the Tampere urban region, Finland. The theoretical views and empirical analysis are synthesized in the discussion section. Lastly, the results of this article are briefly encapsulated in the concluding section.

2. City as a Dissipative Structure

The views of the ontology and fundamental features of the city vary depending on the perspective. It can be seen as a dense human settlement, a collection of buildings, or a hub of innovations [32,33]. Yet, if we wish to understand the ontological dimensions of the urban, we must go beyond such higher-level activities and manifestations, and look at cities as complex biophysical entities. This opens up a view of the dynamic form of the city, depicted in such conceptions as urban ecosystems, metabolism, dissipative structures, self-organizing systems, and so forth. They highlight cities' connection with nature, on the one hand, and their natural complexity, on the other. Rees [34] has argued for the importance of the Second Law of Thermodynamics, or the law of entropy, as the basis of urban ontology, which starts from the premise that any spontaneous change in an isolated system increases its disorder. Rather than gaining in such processes over time, systems are subject to entropic decay. All systems—including such complex entities as cities—are open systems that exchange energy and matter with their host environments. The ecosphere is, in this respect, the major reference as a complex yet highly ordered self-organizing system and multi-layered structure, which presents its complex forms and manifestations every day in front of our eyes. It is the host environment of all human settlements [34].

Cities as dense human settlements are complex and dynamic self-organizing systems. At the very fundamental level, just like any system, they develop and maintain themselves by extracting usable energy and material from the ecosphere, process them internally in order to maintain or reshape their structure, and export degraded energy and material wastes back to its host. Cities can be seen as an analogy of living organisms, which maintain their localized organization as far-from-equilibrium systems at the expense of the entropy of their immediate host system. Such systems are called 'dissipative structures,' which reflects the reality that all self-organizing systems survive by continuously dissipating the available energy and matter [35]. Even if cities are ontologically different from living organisms, they are nevertheless self-organizing dissipative structures, which import and export energy and matter across their boundaries. Their outputs and outcomes vary due to irreversible internal processes, referred to as dissipation [35–40]. Rees [34] points out that "[c]ities, however (indeed, the entire human enterprise), are open, growing, dependent subsystems of the materially closed, nongrowing finite ecosphere" (p. 252). This is an important conditioning factor for urban life and one of the starting points of the sustainability agenda. While there is nothing inherently unsustainable in our ecosystem, changes in human activities have caused planetary-scale disturbances. Rees [34] reduces this to a simple maxim: "the human enterprise must not persistently consume more than nature produces, nor generate more waste than nature can assimilate (with a generous allowance for the thousands of other consumer species with whom we share the planet)" (p. 253).

Such a view of cities contains elements that provide the basis for two overlapping perspectives on cities, giving impetus to slightly different kinds of elaborations. First, as cities process energy and matter, their ontological nature connects them to process philosophy, and can be used to conceptualize cities as an urban metabolism or as flows that generate values for the urban community. The same can be said about more focused analytical tools and approaches, such as industrial ecology and industrial symbiosis [41]. Second, Prigogine's theorizations can be used to analyze cities as systems, which builds connections with urban ecosystems and various versions of systems analysis. Flows and systems are inherently inter-related aspects of reality that are synthesized in the idea of cities as dissipative structures. They are reflected in such concepts as an 'urban metabolism' and 'urban ecosystem,' the former based on flows, and the latter on system thinking. When thinking of cities, both of these dimensions are of critical importance as they provide conceptual tools to understand the system–environment relations, in which "some of the properties and behaviours of certain urban systems depend on interactions between their parts and with the surrounding environment" [38] (p. 266). Figure 1 illustrates the idea of the city as a dissipative structure.

The rudimentary view of a city as a dissipative structure assumes that the *energy* needed to power devices, maintain infrastructures, and provide heating, and the *materials* used primarily in constructing buildings and infrastructures and creating products, are needed to build and maintain the support structures, utilities, and services to sustain essential urban functions, which further contribute to the sustainability of urban communities. The city is a multi-layered entity that serves functions that can be—in the purpose of showing the teleological aspects of the system and its social ontological base—reduced to the intentions of human actors whose actions are constitutive in the building and development of a densely populated urban community. Through organized human activities, the city processes energy and material resources absorbed from the external environment and emits wastes and pollutants, while decreasing its internal entropy through self-organization, in which the role of information and societal structures are essential. Resource flows feed cities, which metabolize and use them to sustain their order and structure over time [38].

From the point of view of circularity, this model reveals an important ontological feature of the urban system; its flows, including waste, eventually either remains in the system to be recycled or incinerated, thus burdening the ecosphere, or exit the system and place burden on other open systems. While low-entropy resources must come from other open systems, most notably countryside-systems, as cities cannot produce them by

themselves, a large part of the waste is also transported to other systems. Cities depend largely on the countryside, while the increase in circularity is the primary strategy in the pursuit of envisioning an autonomous city in terms of energy and matter [42].
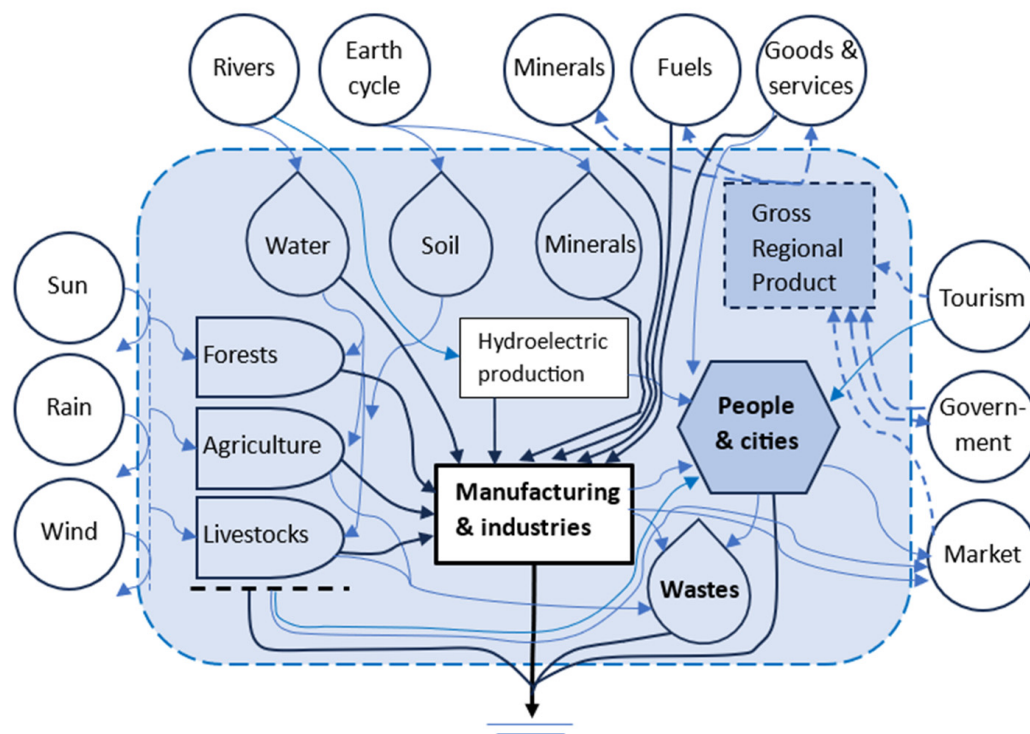
Figure 1. Illustration of the flows of resources within the boundaries of a social-ecological system. Modified from [38] (p. 267).

While cities can be viewed as urban ecosystems, there are a few important aspects that diminish the clarity of this picture. First, even if we may discuss a 'city' as an urban system, it is factually a collection of interrelated open systems, which makes it a kind of system of systems. Some of these subsystems are essential in terms of the order and functions of the city, while others may be secondary or non-essential. The other important point is that the boundaries of city-systems depend on how they are defined. Cities have their borders, which mark their jurisdictions, yet they usually form functional systems that go beyond their borders. Lastly, while 'urban ecosystem' usually refers to the ecological aspect of the urban, there are also concepts like 'city ecosystem' or 'smart city ecosystem', which have a slightly different scope as they refer to people, resources, and capabilities within the technosphere [43]. These highlight the importance of conceptual demarcations in CC research. The interrelatedness of the ecosphere and organized economic activities within the technosphere are illustrated in Figure 2.

Understanding the relationship between the technosphere—i.e., the part of the environment created and modified by humans [45]—and the biosphere can be analyzed through their primary flows. The metabolism of social-ecological systems reflects the interaction of the economic process with the biosphere [46]. The distinction between the activities of the catabolic part and the anabolic part in the metabolic process plays a crucial role in making sense of circularity. The *catabolic part* takes place in the primary production sectors of the economy (agriculture, energy, and mining), which make the secondary flows available to the rest of society, while the activities of the *anabolic part* take place in the remaining sectors of the economy, such as residential, manufacturing, services, and government functions. The latter part of the picture reflects our understanding of the economic activities that are needed to build and maintain the structural elements of society and human wellbeing [44]. From the point of view of atmospheric environmental policy and governance, our challenge

is ultimately to design the benign coordinated interaction between the economy and the atmospheric environment so that bilateral enhancement is possible [47].
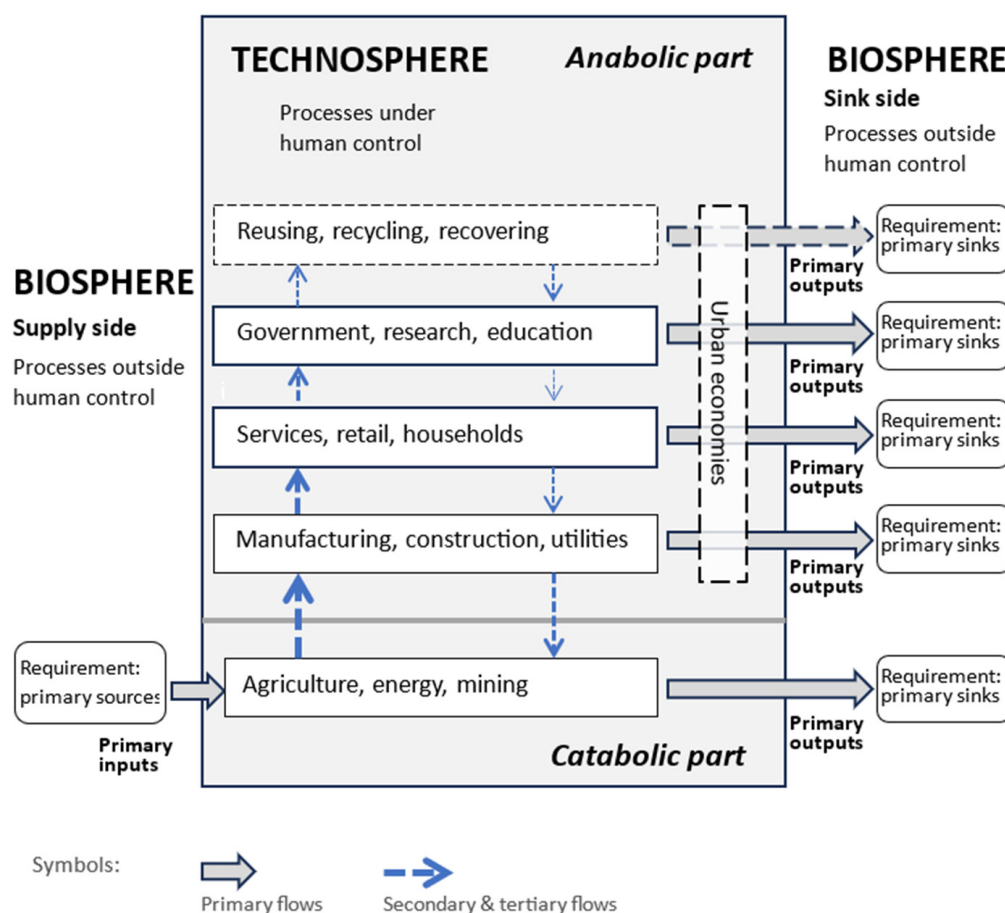
Figure 2. Different types of flows in the metabolic pattern of the economy. Modified from [44] (p. 42).

3. Urban Circular Economy

The essence of circularity in the given context is about the circulation of materials, be they resources or waste. The aspirational aspect of the use of this concept is that through increased circulation, the generation of waste is minimized. In its paradigmatic form, the idea of a circular economy is presented as an antidote to the linear economy and the related take-make-use-dispose pattern that appears to be wasteful, deplete our natural resources, and cause environmental damages, as manifested in the millions of tons of trash large cities produce every year [9]. The linear economy represents an old-fashioned value-creation paradigm inherited from the industrial age, which is based on a narrow view of the responsibilities of economic actors in production and consumption. To overcome the problems caused by such thinking, a circular economy has emerged to close the cycles of raw materials in the value-creation processes [48].

Circularity is primarily discussed in the economic context due to its roots in a model of production and consumption, hence the widely used term *circular economy*. Following the conceptual elaboration of Korhonen and others [49], we may define a circular economy (CE) as "a sustainable development initiative with the objective of reducing the societal production-consumption systems' linear material and energy throughput flows by applying materials cycles, renewable and cascade-type energy flows to the linear system. CE promotes high value material cycles alongside more traditional recycling and develops systems approaches to the cooperation of producers, consumers and other societal actors in sustainable development work." It rests on a fundamental ontological layer that was briefly described in the previous section. The identification of such a fundamental ontological

layer of urban circularity is vital for our theoretical understanding of the flows of the energy and matter of the CC [50–52]. This is a fundamental layer that needs to be supplemented by multiple scales and layers that take into account various principles, sectors, and activity areas according to which we organize urban life. In natural sciences, engineering, and business studies, various CE models have been developed, through which the aspects of urban metabolism are connected to a range of industries and special categories of value creation in the economy. Probably the most well-known of such models are R frameworks, which have evolved from the original 3R model (Reduce, Reuse, and Recycle) [53] and various circular business models [54]. Our interest in this article lies elsewhere, however, as the focus is on the role of the city government in setting and implementing the CE policy agenda.

The CE has become a global agenda that is promoted at different institutional levels. It is viewed as a route to a sustainable future, and cities are its critical instances. When zooming in, this approach focusses precisely on the aspects that have been conceptualized in theorizations on urban dissipative structures, urban metabolism, and cities as systems of systems. As cities are complex and, in many ways, centrifugal collective entities, building and implementing such an agenda requires leadership, explicit future vision, experimentations, a sufficient knowledge base, and stakeholder engagement [7].

As defined by Goldmark [9], a CC is one that eliminates waste and keeps materials in use for long periods of time through smart design, reuse, and repair. This definition encapsulates its essence. An alternative, slightly broader definition, which emphasizes governance, is provided by Prendeville and others [7] (p. 187), according to whom a CC is "a city that practices CE principles to close resource loops, in partnership with the city's stakeholders (citizens, community, business and knowledge stakeholders), to realize its vision of a future-proof city." The aspiration is to change the nature of the city from a resource-depleting throughput system to a self-sustaining circular-flows ecosystem [34]. In order to express both its ideal form and essential urban aspects, we may conclude that *circular city* as a development-oriented city label refers to: (a) a dense resource-efficient community with (b) closed-loop urban cycles that eliminate pressure on nature caused by human activities (c) as defined and guided by various strategies based on design, production, use, and value recovery models and supported by physical, institutional, and digital structures that (d) contribute to the attainment of democratically decided circular city goals as articulated and promoted by the city government as the key instance of urban governance (e) in which local manufacturers, distributors, retailers, consumers, and other stakeholders are involved through various modes and forms of public governance.

Urban circularity relates to both production and consumption systems. The primary focus in the CE has been on businesses, as they affect circularity through industrial systems [55]. Cities usually rely on their hinterlands for a large share of their primary materials and greenhouse gas emissions [52]. On the flip side, cities have their material and carbon footprints of households. Regarding household consumption, food, housing, and transport are the hotspots of both material and carbon footprints. There is some evidence to claim that with consistent CE strategies and action plans, cities may mitigate between 7 and 26% of their material and carbon footprints depending on which domain we are talking about [30].

4. Critical Aspects of Smart Circular City

The smartness of smart-green transition implies that the view of urban metabolism [56,57] is supplemented by the view of digital technologies, thus creating a link to a smart city discourse [23]. This is a way to build a connection with technologically oriented urban development that encompasses manifestations and intersections of natural, built, and digital environments [11]. From the management point of view, there are actually many overlapping areas in CC and smart city concepts [24]. Thus, *smart circular city* (SCC) builds on the idea of a circular economy in the urban context, with a focus on digitally enhanced smartness.

There is an obvious need to rethink what it takes to embrace de facto environmental sustainability within the smart city agenda [11,58]. The other side of the picture is that technology itself has a complex relationship with society. That is, the societal side of the picture goes beyond a technologically oriented view of a sustainable smart city, which continues to deem technological innovations as the primary solution to sustainability issues. The latter is associated with "illusions of machine fetishism" [59]. The challenge is thus, in essence, to discern those economic [60], political [61,62], and socio-cultural [63,64] contexts that condition the realization of a twin transition with the tensional interplay of the environment and digitality [65]. In such a context, the political system in particular, with its continuous attempts to smarten up public governance, is of vital importance as it is the core process that integrates stakeholders in the policy and governance processes that aim at increasing circularity as part of the roadmap to a sustainable future [66]. Selected conceptual categories of urban smart-green transition are illustrated in Figure 3.
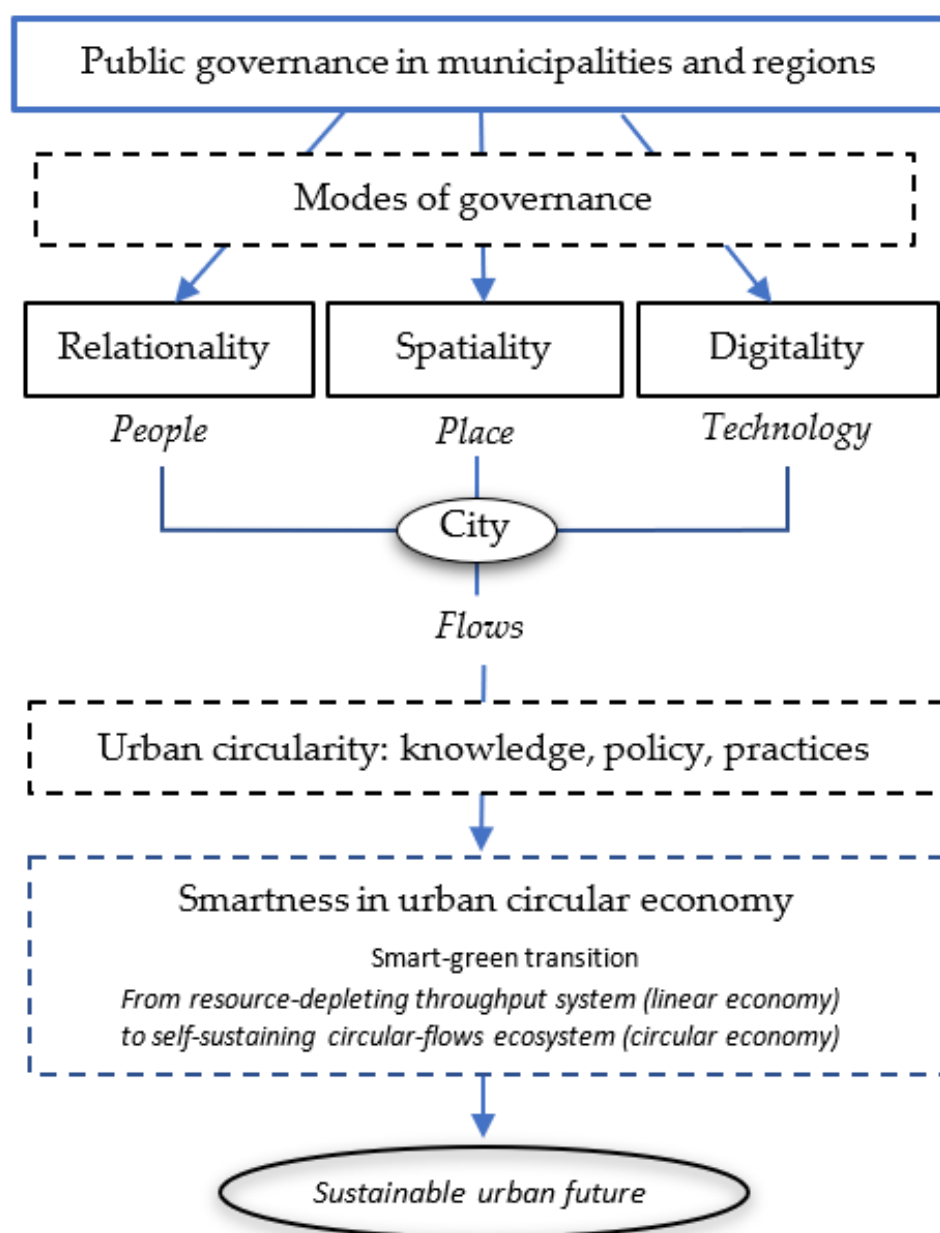
Figure 3. Research setting: the governance of urban smart-green transition.

The way governance connects the key categories of smart-green transition in Figure 3 reflects two methodologically relevant points. First, the connection between circular city governance and the overall governance structure illustrates the learning loops, and in the case of such a complex issue as circular city policy, both double loop (are we doing right things?) and triple loop (how do we decide what is right?) learning [67]. Second, Figure 3 depicts a simplified research setting in which urban governance is used as a lens through which the selected aspects of circular city policies are analyzed and assessed.

4.1. Relationality of Smart-Green Transition

The relationality of urban-regional dynamics has its factual and experiential sides, of which the former is based on behavioral patterns and outcomes and the latter on spatial imaginations expressed in strategy documents and utterances of local and regional players of the circular economy ecosystem, within which the tensions between the sectoral and territorial principles of policy organization are addressed. While the relational complexity of territorially focused governance processes is firmly rooted in locality, the true nature of relationality is often hidden behind traditional framing and categorizations that determine how places are seen in governance processes. As emphasized by Healey, while institutional settings may give an impression of a high degree of clarity and smoothness of governance processes, in reality, "the trajectories of the discourses and practices of governance activity in particular arenas evolve in interaction with their institutional settings, which are themselves relationally complex and dynamic." [68] (p. 10). The politicians and public managers involved in such a spatial strategy-making for urban regions may design policies and imagine futures, but what factually evolves through time has an inevitable tendency to escape their grasp. This is what relationality aims to reveal about the reality of urban governance and the related planning, design, and development activities [69].

The relational approach emphasizes the multi-level and inter-sectoral web of relations, thus feeding the emergent intersections and disjunctions. Such relations are understood as webs with diverse morphologies—hierarchies, partnerships, markets, contracts, volunteering, etc.—connecting people in nodes with varying scales, levels of intensities, and distances. In addition to the theoretically oriented view of urban planning, this approach also derives from transaction cost economics and the sociological exchange literature that addresses the concrete manifestations of relationships in both business and social life. It also provides a view of those actions in relationships that are taken jointly or have a collaborative element in them, including risk-benefit sharing. Such an approach is suitable for relations that need to be built in uncertain conditions. Relationality in an interorganizational context has its manifestation in the so-called obligational contractual relations (OCR) that highlight the features that, in governance theory, are associated with networks, such as reciprocity, trust, and interdependence. Such relations, when sustained for a long period of time, evolve in their ideal form towards a trusted relationship in which formal contracts are no longer needed or become mere formality. In public governance, such a relational aspect is visible in the networks and partnerships that are designed to operate in a setting that serves as an interface between public/bureaucratic logic and business/market-oriented logic. What is needed in such a field is a reflexive capacity to balance different demands [70].

Developing a strategy in the context of relationality involves connecting knowledge and relational resources, known as social and intellectual capital, to generate mobilization force, which can be understood as a form of political capital. If successful, through the utilization of such resources with the help of mobilization, power nodes emerge in networks, from which a strategic framing discourse diffuses outward [68]. Circular economy discourse is an outcome of such a process, and it has indeed become a powerful discourse, which has a connection with the social and material processes that determine the nature and outcomes of a social–ecological system (SES). Through an understanding that extends from a formal dyadic relationship with three components—self, self vs. other, and jointness—towards the web of relationships, relationality aims at building a nuanced view of the practices that guide a social-ecological system, thus overcoming the interpreta-

tive limitations of the rational schemes that ignore the anomalies that do not fit into their explanatory framework [71].

While relationality is an important view of social relations and transformational processes, it has a dialectic relationship with its structural and spatial contexts. There are still features like capital accumulation in the economy, asymmetry in power relations, and institutions which shape social reality with their ability to utilize various resources of power. Thus, relationality as such does not empower actors or change social relations. It can work both ways—that is, it can both shake and entrench power structures or social asymmetries just the same way as, say, networks and partnerships [72]. However, relationality helps in understanding how power flows through all formal and informal relations, and how this relational power can be used to bring about structural reforms. The other important contextual factor that highlights the importance of relationality is that the overall logic of liberal Western democracies has changed the relevance of relationality dramatically: none of the actors in the field of production or public governance can rely solely on hierarchical power, which has gradually increased the value of various aspects of relationality. This is one reason behind the increased relevance of a relational understanding of such complex human creations as cities [73].

The understanding of the urban in the global context must embrace both its territorial and relational aspects, its fixity and flows, its global relationality and place-specificities, and structural imperatives and local choices. That is the very basis of understanding the nature of contemporary urban governance. Against this background, such developments as the Business Improvement Districts (BIDs), livable neighborhoods along with the ideas of New Urbanism, or financial districts, urban knowledge parks, and other urban enclaves that serve as the hotspots of the global economy, are the combined outcomes of relationality and territoriality [74]. In the same vein, place-making can be conceptualized as an urban expression of relationality [75].

Each place in such relationally evolving processes emerges as a locus of place-based anchorage, making either implicit or explicit reference in each situational context, which through place-based nodes brings the place into constellations of networks. They are "institutional sites, with particular material geographies." Each physical place serves as a natural integrator of both the social and the physical. Such a double creation process extracts and utilizes flows of values, of which some values are attracted by or to the players rooted in a particular place, usually facilitated by the collective actions and policies of that place [76,77]. This picture is relativized in the global age, when multinational corporations, footloose industries, investors, and transnational elites do not face the same time and place constraints as citizens usually do in their everyday life [78]. The spatial aspect of this setting will be elaborated further in the next section.

4.2. Spatiality of Smart-Green Transition

Digital intelligence and circularity in the urban context imply that spatiality is an inherent element of the given setting. Usually, digitalization and spatiality are discussed bearing a progressive view of the spatial inequality or economic geography implications of the digitization in mind [79]. It is a too-narrow view for our theoretical purposes. Regarding the circular side of smart-green transition, the spatial aspect is usually an inherent, although often rather abstract, aspect of the analyses of urban dissipative structures or urban metabolism flows. Spatiality has not been particularly well conceptualized in CC or CE discourses. The situation is not much better in the smart city discourse, in which spatiality is usually an implicit, and oftentimes non-existent, factor. There are, however, a few notable exceptions, such as Angelidou's [25] analysis of the spatial aspects of smart city policies, which provides a sufficient generic framework for our discussion. She discusses smart city strategies with a view of their spatial reference, identifying four relevant spatial axes: national vs. local strategies; strategies for new vs. existing cities; hard vs. soft infrastructure-oriented strategies; and sector-based vs. geographically based strategies. This can also be applied to the analysis of the spatiality of CCs.

Regarding the *national* vs. *local dichotomy*, our focus is on the local level. It goes without saying that urban communities are conditioned by a wider multi-level governance system, in which the role of national government is decisive. This dichotomy is primarily relevant because it urges us to identify the factors that are unique to local strategy processes, favor locally designed arrangements, or reflect a genuine bottom-up approach. Angelidou [25] identifies the following factors that favor local-level strategies: the geographical locus and 'stickiness' of related knowledge; urban-scale competitiveness; cities' ability to engage various constituents on a broad range of activities within q smart urban ecosystem; cities' flexibility in exploring different business and governance models; a manageable size of urban problems that can be addressed locally; and the existence of a large number of cities, which creates a pool of peers or suitable benchmarks that can be utilized in local development processes.

Whether smart-green transition is designed on the basis of an *existing or a new city* is a critical issue in many respects. While genuine large-scale new town or new city projects are most common in Asia, in the contemporary Western context, such developments are usually about new urban districts that are themed enclaves designed to serve some function in the global economy. Circularity makes no exception. Even if there are megaprojects, such as Masdar City in Abu Dhabi, UAE, circularity is usually associated with smaller-scale industrial area development projects, such as the Kalundborg industrial park in Denmark or the ECO3 bio and circular economy business park in Nokia, or such neighborhood or residential area developments as Hiedanranta in Tampere or Kera in Espoo, Finland. The idea is to use small-scale socio-ecological innovations in area development as building blocks for promoting urban circularity. In contemporary Europe, these kinds of development efforts are primarily directed at existing cities or urban fringes or enclaves. New town projects look less attractive due to several factors that condition development in the "old continent," including environmental rationality, the pattern of European urbanization, financial challenges, the ageing population, and shrinking cities [80].

Another spatially relevant issue is whether the focus is on *hard or soft infrastructure*. While this is obviously critical in the development of smart cities, it has a direct connection with the development of circular cities as well. In the smart city context, this axis refers, in its paradigmatic form, to the choice between technological advancements in the city's hard infrastructures, such as transport, water, energy, or waste, and the soft infrastructure of the city, referring to social and human capital, social inclusion, participation, and public services in smart city development. This is actually a paradigmatic issue, as the belief in the power of technology to enable the desired urban transformation is an approach that reflects the modernist approach and related technological determinism. Many solutions that fall into this category are based on vendor solutions, such as IBM's Smarter City concept or Cisco's Smart + Connected Communities. It is fair to remind the reader that most of the smart city advocates see such an approach as insufficient, as it is commonly acknowledged that the ability to utilize new technologies depends on various conditioning societal factors.

The fourth axis is the dichotomy of *sector* vs. *area focus* in policymaking. In the smart city context, the sector usually refers to economic sectors, but it can also refer to any urban function or a set of activities. A sector-based approach is a de facto mainstream approach, as the utilization of technologies is characteristically connected with a particular economic sector, cluster, or industry, such as a high-tech business cluster, housing, health, or education, with a focus on the performance of a relevant group of actors, while the geographic reference is ignored or has a marginal role. Many smart city solutions on this front address the issues of sustainability and circularity, such as smart city solutions to buildings, energy, water, transportation, and so forth. A good example of the sector-based approach is Singapore's Intelligent Nation 2015 (iN2015). At the other extreme, there are approaches that focus on specific areas, be it a region, a city, or an urban district or a neighborhood, which means that the development efforts are inherently integrative and use the specific locality as a reference point. According to Angelidou [25], "[t]his is a spatially-determined perspective that acknowledges the prevailing character and main

functions of the city's districts and develops applications to organize and support their effectiveness" (p. S6). Such an approach enables the utilization of the economies of scale or scope, depending on the size and features of the urban community. A good example of the local area development approach is the city of Thessaloniki, Greece, which in its Intelligent Thessaloniki initiative, focused on the most important innovation, entrepreneurship, and logistics districts—the CBD, port, campus, technology district, and airport area—to be smartened up each in their own way. In all of these strategically important areas, the idea was to create smart environments that support the functions of the given functionally differentiated areas, and through such improved functionality, support the development of the host city [81].

4.3. Digitality of Smart-Green Transition

The previously discussed relationality has a critical connection with digitality due to the fact that such technologies "are becoming increasingly adaptive to the social and socio-technical structures they are embedded in" [82]. It is partly via this same social element or sociality that the digital intermediates circularity, or more broadly, with ecological sustainability, which, at the higher level of abstraction, refers to a critical connection between the technosphere and ecosphere.

While smartness has many dimensions and layers, in the smart city discourse, it is inherently related to digitalization or digital intelligence—or, more generally, various aspects of the utilization of a range of new technologies. *Smart city* is a multi-dimensional urban development model, in which artificial intelligence and other technological advancements are used to exploit the collective intelligence and systemic capabilities aiming to enhance competitiveness, effectiveness, quality of life, and sustainability [83]. The smartness within such a model was originally about social or collective intelligence and the processes associated with community informatics, but has diversified since the 2000s in terms of the types of smartness— the basic dichotomy being between social and artificial intelligence—and different aspects of smart urban development, including community life, interaction, and informatics; manufacturing, services and other economic activities; infrastructures, utility networks, and logistics; consumption; urban policymaking and governance; and urban ecosystems and various aspects of sustainability. A motive behind such a holistic view is to avoid giving smartness a too-narrow scope, and to create an explicit connection with critical urban functions [84,85].

In the same way as smart city discourse has embraced the idea of sustainability, smartness has been conceptualized as the ability to increase cities' sustainability and eco-efficiency [86] in the context of city ecosystems [43,87]. Smartness and circularity in the context of urban management actually bear some similarities [24]. Formisano and others [18] found a positive relationship between the two. It is noticeable that "[w]hile the presence of specific smart city-related technologies like AI, Big Data, and IoT are less important for the proliferation of circular economy initiatives in a city, the same is not true for the overall presence of an advanced ICT infrastructure." [18]. The most obvious domain where this connection can be observed is waste management. This requires a nuanced view of the intersection of smart city and circular city discourses and the dialectic relationship between digitalization and circularity (e.g., [88]).

The digitalization of urban metabolism is, in essence, about the means of identifying, controlling, utilizing, and evaluating a range of data on the flows of resources that constitute the urban metabolism and the related social, political, and economic aspects of urban development. Such technologies are varied, including Internet of Things (IoT), sensing technologies, GPS tracking, augmented reality, sharing platforms, and social media sites, and enable us to control such areas of urban life as mobility, waste, water, energy, food, and consumption. There is also a considerable amount of literature published, especially since 2017 or so, on various technologies at the intersection of the smart and sustainable city concepts that directly or indirectly discuss the smartening up of the circularity of urban metabolism [65,89–91]. This highlights the importance of understanding

the complexity of cities, including the ontology of urban flows and other aspects of urban metabolism [34,51,92,93], as well as the special aspects of urban circularity and the formation of a CC [7,28,94–102]. While cities are local nodes of flows, they also have the potential to improve the functioning of, and the benefits gained from, these flows through integrating them with the help of advanced digital technologies. This all revolves around the knowledge processes that enable "identification, collection, traceability, monitoring, analysis, evaluation and redefinition of the circularity of the social, economic and environmental processes and operations" [65], which implies that the role of data management is critical to the optimization of urban processes [57,85,90].

5. Direction, Coordination, and Integration through Urban Governance

Circularity relates to a wide range of activities, from food to transportation to manufacturing, which implies that public authorities must promote it through various means of public governance. The design of sector-oriented CE policies and place-oriented CC policies are, in the representative democracy, dominated by politicians. While policies include regulation and other measures that are based on governance by hierarchies, the success of such a complex issue requires reaching out to various institutions, communities, and organizations, as well as the citizens and users within a city. True change depends on the involvement of the relevant actor groups in practically all sectors of society. There are various principles, forms of intervention, and tools to be used in justifying, defining, deciding, and implementing urban circularity [3,7,28,62,103,104]. This boils down to the view that urban governance has a critical role in involving stakeholders in the design of CC policies and, more importantly, inviting and persuading key stakeholders into the implementation of such policies, or as it may appear to be, even become innovative frontrunners in selected policy areas, industries, or practices. Rather than acting as a gatekeeper, the city government should be portrayed as an institutional facilitator with a mission to attract, engage, and retain local stakeholders to the promotion of a CC according to the will expressed by the city council.

5.1. Governing Smart-Green Transition

The traditional way of reaching out to key stakeholders has been through such means as regulation and de jure standards. However, the tentacles of CE are stretching to a wide range of sectors, urban functions, and activities, which require a sophisticated approach from the city government as the primary instance of local governance. There is a tendency to go beyond regulatory schemes towards adhocracy, networks, ecosystems, and platforms [60,105–107], which reflects the evolution of the approach to an urban CE from the government-managed waste sector and regulatory measures that strive for a narrowly defined closed-loop economy towards a sophisticated understanding of a CE that is regenerative by intention and design, highlighting the role of the private-led resources sector, i.e., a sector that manufactures, sells, and distributes products and product-service systems using natural resources as its raw materials [108]. The integratedness of the agenda has been intensifying gradually, giving all sectors and stakeholder groups a role to play.

Many aspects of the contestation surrounding the CE are not addressed in the conventional governance processes, although governance arrangements linked to the CE are critical in shaping the vision and involving the key actors in the pursuit of the desired change. Thus, the role of governance itself is being remolded gradually to better match the challenges of stakeholder-involvement in the realization of urban circularity or the broader sustainability transition [109]. On the other hand, policymaking around CE issues may occasionally become a tensional intersection of differing ideologies, approaches, and interests, and thus the subject of discursive battles [109–112].

The concept of *smart urban governance* at the intersection of smartness and circularity integrates three dimensions—institutional, spatial, and technological—in urban governance. The initial testing of the model suggests that various aspects of smart urban governance vary depending on the societal context [113]. This implies differences in the mode of gover-

nance and, thus, the way policy matters are coordinated and integrated in the governance process. Interestingly, each mode of governance has a natural connection with spatial imaginations, which brings revealing nuances into the picture of local public governance. In order to illustrate this, let us consider how different governance theories relate to the previously mentioned three dimensions. First, *relationality* is largely a reflection of the emergence of a network logic within New Public Governance [69]. However, relationality relates to all basic modes of governance, although in a rather peculiar way. Namely, hierarchical governance has a tendency to formalize and condition relationality, whereas markets make relations contractual and instrumental, thus ultimately allocating goods and services through the price mechanism. In terms of governance, it is network governance and the related recent developments, such as ecosystem and platform governance, that are more open and constructive towards relationality [114]. Overall, there seems to be a clear tendency towards a non-hierarchically determined relationality that is detached from, or at least becomes complicated, regarding public hierarchies and positional power, which encourages institutional actors to rely on the new ways of building collaborative relationships, seeking synergies, and utilizing the local potential in the promotion of smart-green transition.

Second, the modes of governance have connections with the perception of the *spatial* organization of society. Governance by hierarchies is rooted in the idea of government-led programs and local production systems, governance by market has a strong association with agglomeration and the economies of scale, and governance by networks is associated with imaginations of relationality or relational spaces. Sometimes governance by communities is added to the above three as a special category—either as a reflection of the traditions or of the communities of practice—which has been tentatively associated with 'shared contexts' as its paradigmatic spatial reference [115].

Urban governance reveals a similar variation in its relation to *digitalization*, as seen in the e-government regime typology with four types of regimes: authoritarian e-government, managerial e-government, reform-oriented e-government, and open e-government [116]. In another fairly similar four-fold typology, digitality is connected with the bureaucratic, consumerist, platform, and participatory governance paradigms [105]. A more technology-oriented view of governance is the maturity-based typologies of digital public governance [117]. In urban planning, four emerging technology-driven governance patterns have been identified, including algorithmic urban planning within the smart city framework, privatized practices of uberized urban planning, open-source urban planning enabled by democratic local institutions, and activist- and communitarian-oriented "wikitized" urban planning [118]. Such conceptualizations help us to understand the ways that governments perceive new technologies both as governance tools and as an aspect of urban development. At the local level, this boils down to the question of how the city government utilizes new technologies in promoting the CE. The interests, ideologies, and structures that determine the relationship between governance and digitality, reflecting a kind of digital governance paradigm, give a hint of how digitalization is utilized in the facilitation of relationality bearing spatially articulated conditions and benefits in mind in the pursuit of smart-green transition. The connections between these key concepts are illustrated in Table 1.

Table 1 shows that governance models have connections with the three contextual categories discussed above, i.e., relationality, spatiality, and digitality. This suggests that the mode of governance may serve as the anchor that increases congruence and integrative elements between these three factors. This is a tentative, theoretically grounded scheme, which can be used as a framework for discussing the realities of smart-green transition in different societal contexts.

5.2. Integrative Views of Smart-Green Transition

The integrative view of smart-green urbanity has had its expression in one of the recent city conceptions or labels, smart sustainable city (SSC), which highlights the reshaping of the

smart city discourse under the sustainability umbrella. While a smart city is still primarily a technologically and economically oriented concept, it has been re-defined on many occasions to better reflect the ecological conditions and realities, including the issues of the climate change and circularity [21]. Sustainability brings a vital supplementary element to smart city concept, most typically applied to water, waste, energy, and other utilities and infrastructures that are deemed critical in terms of wellbeing and sustainability [119,120].

Table 1. Modes of governance and urban smart-green transition.

Mode of Governance	Circular City Approach	Relationality	Spatiality	Digitality
Hierarchy	Institutional; programmed; top-down	Authority; hierarchical relations; regulations	Local production systems	Authoritarian e-government; technology-oriented approach
Markets	Distributed; incentivized; business-oriented	Exchanges; instrumental relations	Agglomeration	Managerial e-government (e-NPM); business solutions; business ecosystems
Networks	Persuasive; multi-actor setting	Reciprocity; trust; pooling resources	Relational spaces	Reform-oriented e-government; digital platforms
Communities	Community-oriented; self-organized; volunteering	Traditions; sharing	Shared space	Open e-government; social shaping of technology

The ITU-T Focus Group on Smart Sustainable Cities went through several definitions of a SSC and ended up with the following definition that encompasses its main attributes: "A smart sustainable city (SSC) is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operations and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" [121]. An important element of this discussion is the one that replaces the generic idea of sustainability with circularity. A discussion about the smart circular city (SCC) is emerging, which aims at providing a holistic view of a CC that makes sense of its multi-dimensionality, interconnectedness, and systemic nature [56].

6. Methodology

This article has its roots in systems thinking, which provides a view of how people and their communities interact with nature. Such systems can be referred to as social-ecological systems (SES) [122]. An interesting trend within SES research is its increased inclination to seek conceptual and explanatory categories from systems science, complexity theory, and theorizations of complex adaptive systems [123,124]. Building on such premises, this research process follows theoretically oriented research supplemented by an exemplary case study. The case serves as a 'crystallizer' that offers insightful conceptual schemes and novel views of urban governance, which are potentially useful for other, similar kinds of cases [125]. This research process proceeded with the steps described briefly in Table 2.

Table 2. A brief outline of the research process.

No	Step	Description
1	Research problem	Knowledge gaps have been identified and research problems defined as expressed in the introductory section of the article. Research problem is formulated as follows: how do the modes of governance relate to the social, spatial, and digital aspects of the smart-green transition of cities in the advanced welfare society context?
2	Theoretical ideas and literature review	This is theoretically oriented research [126,127] with a case exemplification [125]. Due to the complex research problem and several thematic areas each having their own discursive roots, the initial scoping review was based on specific key words (circular city, smart circular city) as well as the initial review of existing systematic literature reviews. These were complemented by the review of literature on specific theoretical concepts within CE context. Such reviews were utilized in building theoretical framework for this article [128,129].
3	Research design	Research design and methodology is based on exemplification of theoretically based ideas. In this theory-driven analysis empirical evidence is obtained through an exemplary case [130,131], bearing thus a similarity to case study methodology [132].
4	Data collection	Data collection relies on a case description, relevant stakeholder interviews, and the review of selected documents (see Appendices A and B)
5	Data analysis	This article is based on a theory-driven analysis of the case of Tampere urban region. In the discussion section empirical findings are assessed against the findings of prior research.
6	Findings	Findings are based on theoretical discussion and exemplifications of empirical analysis. They are presented in the concluding section of this article.

This is primarily a theoretically oriented endeavor that relies on a review of the relevant literature [126,127], which is used to highlight how the smart-green interplay has been approached on both sides of the aisle, i.e., in smart city discourse and CC discourse. As there are several literature reviews already available in both discourse fields, they are utilized in mapping out the research in this area. Emphasis is put on the CE and CC discourses [14,28,65,89,95,107,133].

While a theoretical discussion provides an overall view of the governance of a smart transition to urban circularity, its connection with real-life development must be validated. For this reason, this article presents an empirical case that is analyzed based on a comprehensive theoretical framework. The illustrative case is municipalities of the Tampere urban region in Finland. When thinking about the urban smart-green transition, it is plausible to assume that countries with an advanced digital government and dedication to progressive environmental policies would be in the forefront. Finland was the first country in the world to prepare a national road map to a circular economy in 2016. It is, therefore, an interesting case in its own right. Finland represents the group of Nordic countries that are known for their welfare society development and a Nordic model of public governance. They have evolved towards hybrid governance, which includes overlapping aspects of bureaucratic public administration, New Public Management, Neo-Weberian State, and New Public Governance [134].

Our case represents a local view of the CE development in Finland. The cornerstone of the Finnish administrative system is the progressive local government, which has a critical role in promoting the CE. This is a characteristic feature of Finland, with its long history of development-oriented self-governing multi-purpose local governments (of such cases see, e.g., [135]). In this article, the smart-green development is illustrated with the case of municipalities, regional intermediaries, educational institutions, and companies in the Tampere urban region. Our main focus is on two municipalities in the Tampere urban region, those of the city of Nokia and the city of Tampere.

The data are obtained primarily from the interviews of key actors of the circular economy ecosystem in the Tampere urban region (on illustrative case study, see [136]; on the methodological relevance of exemplification, see [125]). The informants represent the following organizations: Economic Development and Urban Development units of the city

of Nokia; Regional Waste Management Company; Business Tampere; the development corporation Verte of the city of Nokia; a private company that operates at ECO3 eco-business park; Tampere University; Plot team of the city of Tampere; and Ekokumppanit Ltd. (A detailed descriptions of interviewees and their organizational affiliations are described in Appendix A). Qualitative in-person research interviews were conducted in March-April 2022 by Research Assistant Akseli Tiensuu (interviews 1 to 7) and in June 2023 by Research Assistant Aku Puskala and Senior Lecturer Markus Laine (interview 8) and Aku Puskala and Akseli Tiensuu (interview 9) in a collaborative project of Tampere University and the Urban Research and Statistics Unit of the City of Helsinki, financed by the Academy of Finland for 2022–2025. Informants are presented anonymously in the empirical analysis. Direct quotes from the text transcripts have been translated from Finnish into English by the author.

7. The Case of Tampere Urban Region

7.1. The Multi-Level Governace Framework

All of the cities organize their policies and activities within a multi-level governance framework, which includes global, macro-regional, national, regional, and local levels. Although the global and macro-regional levels are not the focus of this article, they have their impact on various aspects of local CE policies [137]. Regarding the EU member states, such as Finland, the European Union (EU) plays an important part with its circular economy policies that affect the national and sub-national authorities within the union [138].

Finland is a Nordic welfare society with some 5.5 million inhabitants. The circular economy is deeply integrated into the development of the country. Finland was among the first countries in the world to develop a circular economy roadmap, its environmental performance is good according to the relevant global rankings [139], and it has made the commitment to strengthen the circular economy and to be carbon neutral by 2035 [140]. According to an international comparison, Finland stands out in the field of CE policy as a country with strong CE leadership, a comprehensive policy plan and product policy on CE, as well as advanced CE practices, such as a medium percentage of recycled household waste and a low percentage of waste going to landfill [141,142].

Although our discussion focusses on the Tampere urban region, some of the collaborative actions of the municipalities of this sub-region relate to larger regional configurations, as with the case of the formal collaboration within the Council of Tampere Region, which is a joint municipal authority. It has 23 municipalities as its members, with a population of over half a million. Regions at the intermediary level have their own CE promotion activities, in which the municipalities of the Tampere urban region are involved. Tampere Region is one of the regional frontrunners in circularity in Finland. It is also one of the European Union's pilot areas in the Circular Cities and Regions Initiative (CCRI) (https://circular-cities-and-regions.eu/ (accessed on 20 March 2023)).

Another important regional player is the inter-municipal waste management company, Pirkanmaan jätehuolto Oy, which takes care of the statutory waste management services for 17 municipalities, including the municipalities of the Tampere urban region. There are some 460,000 inhabitants in its catchment area. The formal administrative responsibility of waste management in the area is vested to a regional waste management committee, and the supervision is undertaken by the municipal environment protection authorities. The Committee is responsible for statutory waste management functions, while its administration is handled by the city of Tampere. This implies that the local authorities in the Tampere urban region operate within a multi-layered governance field.

7.2. Tampere Urban Region and Municipalities

The Tampere urban region is the second largest metropolitan area in Finland. *Tampere city* proper, with some 250,000 inhabitants, is the most populous inland city in all of the Nordic countries. The city is an ambitious player in the circular economy and sustainable development (see Doc3; Doc5). The *Tampere urban region* is a functional urban area with

a loose administrative structure designed for intermunicipal collaboration. When emphasizing the sub-regional collaboration, this area is sometimes referred to as the Tampere city region (https://tampereenseutu.fi/en/ (accessed on 20 March 2023)). It includes eight municipalities, those of Tampere, Nokia, Ylöjärvi, Lempäälä, Pirkkala, Kangasala, Orivesi, and Vesilahti. The number of inhabitants is in the region of 400,000. A backbone of their shared sustainability framework is the sub-regionally prepared carbon neutrality roadmap, which is adopted by all municipalities of the area. The aim is to cut the carbon emissions by 80 percent from the level of 2007 by 2030. The remaining 20 percent is to be absorbed by carbon sinks or compensated. Although these roadmaps are about decarbonization, they have implications in various activities associated with the circular economy.

The location and area of the Tampere urban region and a wider intermunicipal regional authority known as Tampere Region are presented in Figure 4.
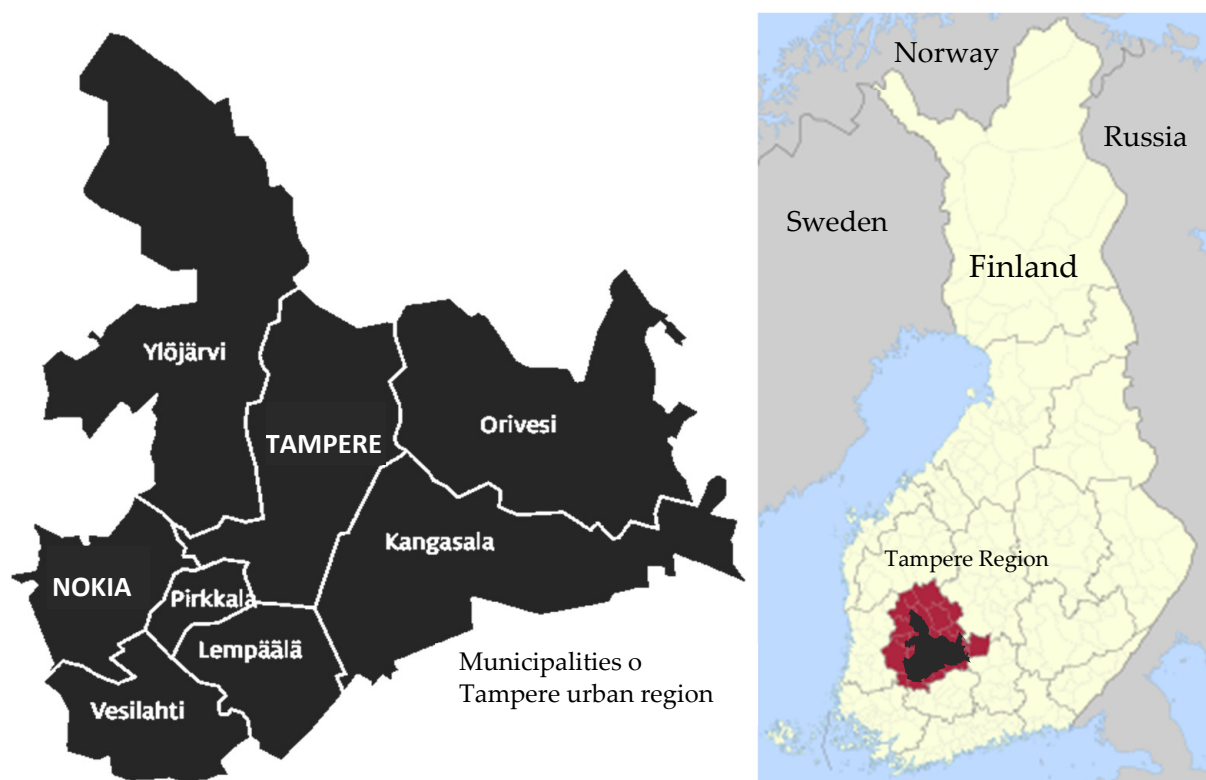
Figure 4. Tampere urban region on the map.

While the activities and businesses associated with circularity are scattered around the entire region, there are certain hotspots worth a special mention. There are small waste stations in different parts of the area. The most important sites of waste management and circular economy business include the Koukkujärvi waste center in Nokia, the Tarastenjärvi waste center, and a nearby Tammervoima Waste-to-Energy Plant in Tampere. In the *Tarastenjärvi area*, on Kangasala's side of the border, there is a new circular economy industrial district known as Taraste Circular Economy Area (Tarasten Kiertotalousalue), which makes this large area one of the major CE hubs in the Tampere Region.

A place worth special mention is the *Kolmenkulma eco-industrial park*, with a cleantech as its primary industrial profile. It is a large area where the borders of the municipalities of Tampere, Nokia, and Ylöjärvi cross. It focusses on material and energy efficiency, new technologies, and renewable energy sources. Nokia's side is divided into several smaller districts, of which the most important in terms of the circular economy is the area known as *ECO3*. It is a pioneer in the bio and circular economy, run by Verte Ltd., the development company of the city of Nokia.

Another area worth mentioning is Hiedanranta in Tampere, which is a planned multipurpose residential district for 25,000 inhabitants and some 10,000 jobs that attempts to utilize a wide range of circular economy solutions. In Vuores, at the border of Tampere and Lempäälä, there is an innovative waste collection system and a smart waste station. In addition, in the municipality of Lempäälä, the so-called LEMENE project is creating a Lempäälä energy community, which aims to implement a self-contained smart energy system in the Marjamäki industrial district. All such developments form a Tampere urban region circular economy ecosystem, which brings more than one hundred SMEs and large corporations together in the field of circular economy and cleantech supplemented by several research institutions that conduct research on the CE and contribute to the development of green technology and the related products.

All municipalities of the Tampere urban region are aware of the CE and they are involved in various development processes through projects and networks run by local and regional organizations and educational institutions. However, their own policies and actions are largely focused on recycling, except for the two largest municipalities of the region, those of the cities of Tampere and Nokia. Although Nokia, with some 35,000 inhabitants, is considerably smaller than Tampere, its profile is higher than its neighboring middle-sized municipalities due to its longer involvement in the industrial development associated with the CE. It has started to address the promotion of the CE through its own operations and also serving as an enabling platform, especially for industries. The city of Tampere, as the largest city in the area, has the most sophisticated and strategic approach to the CE. For this reason, in this article, attention is mainly directed to Tampere and Nokia.

7.3. ECO3 Bio and Circular Economy Business Area

In terms of eco-industrial activities, the ECO3 has become the most widely known among the industrial areas dedicated to the circular economy in Finland. It is a nationally important center of expertise developed by the ECO3 platform company Verte Ltd. and the city of Nokia together with companies and universities. Its profile is rooted in the economic profile of the host city of Nokia, revolving around: nutrient cycle based on the utilization of material flows of agriculture, forest, food production, and community life; wood-based bio and circular economy; bio and circularity based energy and fuels; and technical cycles that extend the life cycle and reuse of technical materials, such as minerals, metal, plastic, and rubber (see the website of ECO3 at https://eco3.fi/en/ (accessed on 20 March 2023)).

8. Governing the Smart-Green Transition in Tampere Urban Region

8.1. Relational Aspects of Smart-Green Transition

Official policies, media content, websites, and professional discourses indicate that circularity, as a part of sustainable development and the climate agenda, has become a cross-cutting theme in local public policy and governance in Finland. This is particularly the case with larger cities, which are paradigmatic examples of communities that have started to generate change relying on the idea of circularity [143].

Among the municipalities of the Tampere urban region, the premises of urban governance are described in the most detailed way in the policy documents of the city of Tampere. It also has the most complex governance structure due to its size and leading role as the largest city in the region. The circular economy plan of the city of Tampere describes how the city assumes several roles, such as a major player, enabler, guide, partner, and trainer [Doc3]. This view comprises a complex stakeholder field and particularly addresses those activities over which the city government has direct control. A slightly different view is represented by the city of Nokia, which focuses on the local government's platform function. It relies on the idea that most of the development activities depend, ultimately, on manufacturers and other actors involved in production, distribution, and consumption. This principle is applied to practically all of the actions that facilitate the green transition, such as the development of the ECO3 area. It seems that in building the CE agenda, local

governments tend to focus on their assets and control in a relational manner as they pay attention to how the increased circularity of their own assets and activities affect the diverse groups of external stakeholders, thus making positive externalities, the multiplier effect, and scaling-up possible.

> It is rather seen that we have offered a kind of platform and the land for companies, and they are then those who do and develop, so that we then as a city try to, for example, with permissions policy enable for them to do it by themselves and develop there. So, perhaps it is the kind of division of labor between us. (Interview 1 Representative of Business Development of the city of Nokia)

> The basic idea is that we assess what the public organization can do in different ways in its own activities in order for making it easier for companies to generate business from circular economy. (Interview 9 Representative of Ekokumppanit Ltd. of Tampere City Group)

While an awareness of ecological sustainability is critical regarding the transition in question, it is framed with the question of how businesses are able to adapt to or meet the requirements of circularity. This view is most prominent among the economic development agencies, which are intermediaries between the progressive political agenda and the most important external stakeholder group: local businesses.

> Well, it is in a way a sort of cross-cutting theme of our mission, that is, not only probably circular economy, but this climate action overall and, sort of, the promotion of this kind of low-carbon [development], supporting green transition, in a sense across the board with the companies in our urban region; thus, it is very important, and circular economy is in a sense one part of it. (Interview 4 Representative of Business Tampere)

Circularity is also visible in the regional economic development strategy (Doc1). There is a strong sectoral tendency, however, as this theme has a particularly high profile within the circular economy and cleantech ecosystem. All the municipalities behind Business Tampere have their own carbon neutrality roadmaps (e.g., Doc2 and Doc6), which have been prepared collaboratively among the municipalities of the region, and are supposed to pave their way to carbon neutrality by 2030. Such an agenda is critically dependent on the ability of local governments and their agencies and companies to involve local businesses in the implementation of this policy (Interview 4 Representative of Business Tampere; Interview 8 Representative of the city of Tampere).

> We all share the goal for 2030 to be carbon-neutral and we indeed need for that also those companies. (Interview 4 Representative of Business Tampere)

A similar attitude is visible among businesses, even though there are natural differences across the field. In particular, companies operating at ECO3 show a greater awareness of the transition towards circularity as it is an inherent part of their business. Companies in the construction industry have also expressed a positive attitude towards the city government's use of the circular economy criteria in a competitive plot handover process organized for the Kissanmaa plot in 2022 in Tampere, which is a sign of a certain degree of alignment between public CE policies and the long-term interests of the business community (Interview 8 Representative of the city of Tampere; Interview 9 Representative of Ekokumppanit Ltd. of Tampere City Group).

> In fact, perhaps the most significant change is that investors . . . do not invest anymore in this kind of sort of destructive industry. (Interview 6 Representative of a Private Company at ECO3)

> Companies make their independent decisions . . . but here primarily . . . this action is the kind with many companies that there is at a background a kind of ecology and the production of ecological products . . .. (Interview 2 Representative of Urban Development of the city of Nokia)

Maintaining a balance between CE policy and the primary function of businesses requires a dialogue between the city government and local businesses. Such a dialogue is largely vested to intermediaries. This implies that intermediaries have become "interpreters" that mediate public-private dialogue and thus help in finetuning the pace of CE development.

> We have to know very accurately what is the operational environment of companies, to maintain continuous dialogue with companies on what are you currently able to do, what do you need more, and also keep our ears open to those light means of exerting pressure, which create operational environment and markets but, at the same time, ensure that companies must, to a degree, change their actions. (Interview 9 Representative of Ekokumppanit Ltd. of Tampere City Group)

In spite of the critical role of the political mandate and authority of local government, local public governance is not solely based on hierarchies, regulations, or orders, but relies on persuasion, incentivization, nudging, and voluntary collaboration. It seems that in most of the notable cases in Finland—ECO3 in Nokia, the Circular Economy Centre at Digipolis of Kemi, Syklo in Oulu, Green Industry Park in Turku region, Business Tampere in Tampere Region, etc.—there is some kind of development agency or publicly owned company that mediates public-private collaboration, which is, to an extent, a reflection of the early adoption of the NPM doctrine in Finnish local government.

> This ECO3 is indeed in my opinion here . . . in its own league in a way, . . . how smoothly the interaction works between public and private actors particularly in this ECO3 concept. . . . And for example, public actors, how public actor as a matter of fact can do at the business interface, so that can they enter there and, and what can be done there, and this way it is fairly successful in that ECO3. . . . especially this kind of development company, some kind of entity—that is public entity—that . . . are often this kind of limited companies or others that have embraced market logic, which looks like to be the model, that . . . has been promoted in Finland. (Interview 7 Representative of Tampere University)

The other expression of this policy is the regional climate partnership model initiated by the city of Tampere, which invites companies to participate in climate mitigation and, at the concrete level, contribute to the goal of a carbon neutral Tampere Region by 2030. The model was developed in collaboration with the cities of Tampere, Turku, and Espoo in the KIEPPI project in 2019–2021, in which Hiedanranta in Tampere, Kera in Espoo, and Turku Science Park in Turku were developed as sustainable districts with an emphasis on new businesses and jobs in the circular and sharing economy. The partnership model provides visibility to the climate-related actions of companies, brand benefit, business matchmaking, and networking and partnerships (Interview 4 Representative of Business Tampere)

One of the intermediaries in the Tampere urban region bio and circular economy ecosystem is the ECO3 platform company Verte Ltd., which obtained its advantage by being one of the pioneers in the CE field in Finland. Area development includes a certain degree of self-organization, which guarantees that even if some companies stop their operations, it does not have a too-severe impact on the current circular economy ecosystem. Thus, to avoid making a house of cards or a dominoes game, some degree of self-organization and decentralized logic in the system is required. This is actually a concrete example of how the principles of park management affects the relations of key players within the eco-industrial park.

> The mission of our company is indeed aftercare, and by the same token, beside to attract more, to take care that our companies innovate new solutions. And we have to create such inputs, to create market pull ourselves. . . .All companies will not survive, they may close down their business, and the area should not fall because of that, that one player disappeared. That is why this is not a domino structure, that everyone would be creating added value to each other. That is,

everyone finds their value on their own. (Interview 5 Representative of ECO3 platform company)

In all, the overall picture of urban circularity is that its relationality is rather fragmentary. Local governments have a persuasive approach with a primary focus on businesses. In this policy area, public-private collaboration is well facilitated and policymaking has a strong regional emphasis. Despite the fragmentariness, integrative elements are in the making, as seen in the establishment of intermunicipal and regional institutions and the regional climate partnership model, as well as in the gradually developing platform solutions designed to facilitate decentralization and self-organization.

8.2. Spatial Aspect of Smart-Green Transition

Land use, ownership, and location decisions are critical aspects of community life, livelihood, and development. From a sectoral point of view, location is less relevant, which is amplified by increased mobility and digitalization; however, from the point of view of each urban community, location is far from irrelevant. The question is: how do the circular economy and the promotion of smart-green transition relate to real estate, urban land use, and site selection issues? They are conditioned by the dispersed structure of the urban region and the relatively small size of its central city, which implies some deficiencies regarding real estate companies' involvement in the smart-green transition. The flip side of the coin is a widely shared regional perspective that collaborative arrangements and managerial competences compensate some of the natural deficiencies of the urban region.

At present, the advanced municipalities that have some designated areas to match this trend have gained a reputation as forerunners, as is the case with the cities of Nokia and Tampere, and the ECO3 park in particular. The high profile of Nokia and Tampere is largely due to the development of their large landfill areas, and the same goes for the Koukkujärvi area in Nokia, where the landfill and waste center of the Tampere Region Waste Management Ltd. that serves its 17 member municipalities is located. The operations have developed continuously towards more sophisticated policies and actions that are associated with circularity. Currently, only some 1% of waste has to be taken to landfills.

Circular economy is, however, a good example of the fact that many municipalities respond to [the inquiries of] circular economy players "not available", that is, they do not have any site to offer them. And, in a sense we have started perhaps thinking that we bear a kind of social responsibility in Nokia and offer these companies business site or location. (Interview 1 Representative of Business Development of the city of Nokia)

In the city of Nokia . . . they correctly and smartly understood that this circular economy and the developing businesses around it is the future thing. (Interview 3 Representative of Tampere Region Waste Management Company)

From the point of view of local players, the proximity of collaborators or competitors is not as important as in many other industries, and oftentimes local players emphasize the economic vitality of the area, and even national development, rather than their short-term interests, as shown by the case of ECO3.

This does not mean that they are only ECO3 area companies, . . . [but rather that they have] connections to many other directions. And this is how it should be—that we do this across municipal boundaries. That is how the business works as well, so that in business life they do not take these municipal boundaries into account, and they do not have to. So, it is one of a kind of challenge to the success of eco-industrial park that if local government focusses on the municipal boundaries . . . then it will not succeed at least as easy as in the case in which we have had a leeway to look at the development of this area through the effectiveness of the regional economy. The added value comes from such a broad circle, over regional border, . . . and that is not our loss if a company says that ECO3 is not best site for them. (Interview 5 Representative of ECO3 platform company)

The role of a brand is considered important in determining the attractiveness of the eco-industrial parks and similar business locations, such as ECO3. Areas with a sufficiently well-known brand provides their host municipality with added value in terms of the place brand.

> But the issue whether we have on the other side of the border some other actor, that is not particularly central and essential [matter]; rather I would see that we are able to create a sort of attractive brand, that is, this ECO3 is a kind of strong brand. We create the model that we are marketing. (Interview 3 Representative of Regional Waste Management Company)

> What Nokia is currently known and recognized for, it is really that ECO3 is very often pointed out. And, and thinking internationally, there is a kind of idea when the name Nokia is after all . . . we are probably the most well-known city in Finland, even though no-one there knows that we are a city. Everyone thinks that we are a mobile phone. . . . There are thus international players who are interested in coming to Finland, circular economy players, so, perhaps . . . selling Nokia is easier than selling Kemi, for example. . . . And it is telling already that these circular economy players, who come to us, many of them contact us by themselves. . . . And the best salesmen are of course those companies there . . . And they have already much in common there, that is probably the essential thing. (Interview 1 Representative of Business Development of the city of Nokia)

One of the key aspects of locationality is that there are city governments that develop the circular economy with local interests in mind, often with the help of publicly owned waste management or circular economy companies and the promotion of intermunicipal or regional collaboration. This is evident in all Finnish cities, as reflected in cases like Ekomo in Helsinki, Kiertokaari in Oulu, Topinpuisto in Turku, as well as with regional players, such as Southeast Finland Waste Management Ltd. or Tampere Region Waste Management Ltd. Such a development is ultimately rooted in local authority, as local governments have a responsibility in organizing waste management and taking care of zoning, a political authority and capacity to coordinate local actions, and a sufficient competence in dealing with complex waste management and related policy processes. The local government's authoritative role in representing the local interest has its inherent spatial connection, including decision making on intra-jurisdictional allocation and location issues.

Spatiality is one of the conditioning factors of industrial symbiosis and circularity in eco-industrial parks. Due to the preconditions of ECO3, its development is not anchored on industrial symbiosis per se, but rather on identified cycles –most notably nutrient, wood, energy, and engineered materials cycles– and the creation of value chains that bring added value to businesses. It is emphasized that companies are supported by dedicated public-sector organizations, most notably, the publicly owned ECO3 platform company and the city of Nokia. The idea is to form a platform that supports market creation in a dialogue between companies, municipalities, regulatory and supervisory authorities, universities, research institutions, and publicly owned companies, such as Tampere Region Waste Management Ltd. The focus is on involving businesses in the systemic change towards a sustainable future. (Interview 5 Representative of the ECO3 platform company.)

8.3. Digital Side of the Smart-Green Transition

Since the 1980s, the city of Tampere has put a lot of effort in developing high-tech business, embracing digitalization in the city government, and promoting digitalization in urban development processes. An important development program was the Smart Tampere ecosystem program of 2017–2021 (https://smarttampere.fi/en/home/ (accessed on 20 March 2023)). While many aspects of the circular economy are dispersed around the region, the sectoral view of high-tech leans towards the biggest urban center of the area, the city of Tampere, which is the host city of Tampere University. The city is also a major

player in the industrial spearheads of the Tampere urban region, which include intelligent machines and automation, AI and analytics, imaging, and circular economy and cleantech.

Tampere's approach to circularity is outlined in the city strategy (Doc4) and concretized in the Circular Economy Plan of the City of Tampere of 2022 (Doc3). The idea in CE planning in Tampere is to integrate circularity into all aspects of urban life. It implies that this viewpoint is seen in the city's role as a planning authority, purchaser, developer, and regulator, but also indirectly in its attempt to affect the attitudes and behavior of businesses, housing cooperatives, households, and consumers. The focal development goals of the Circular Economy Plan concern land use, real estate, waste management, and the food system. The horizontal themes of the plan are procurement, sharing economy, education, and digitalization. Many circular economy solutions require digitalization, and the city government holds the view that there is a lot of potential in combining a data economy with the CE. Digitalization can be used to increase resource efficiency, close material loops, and extend the product life. Digital solutions enable distant control, the anticipation of maintenance needs, and sharing (Doc3). However, despite this, digital solutions have a rather modest role in the plan, covering only a few digital platforms or applications. This hints that smartness is an underdeveloped theme in the urban CE agenda, even if the CE was one of the strategic smart specialization priorities of the Tampere urban region, setting the strategic framework for S3 operations. The role of the local university and polytechnic has been important in developing the local CE model and establishing research projects through which many developments have been built, including ECO3 [144]. Smartness is actually an explicit part of the development of ECO3, known as Smart ECO3, which is, however, in its infancy.

Digitalization is a component in several local projects that are based on collaboration, ecosystem thinking, and platform logic. While some of the platforms relate to area development, such as in the KIEPPI project of Tampere, Espoo, and Turku in 2019–2021 and the long-term development of the Hiedanranta area in Tampere, many of them bring regional players together. A case in point is the PirkaCirc project of 2021–2022, which aimed to develop a region-wide innovation and center of expertise platform around the bio and circular economy under the lead of the ECO3 platform company, Verte Ltd., and to facilitate participation in the network of circular economy centers supported by Business Tampere.

Overall, digitalization and smartness are not the primary issues in the current development path towards urban circularity in the region. They do, however, have their role in the agendas of municipalities, Business Tampere, and the ECO3 platform company. Regarding ECO3, smartness via digitalization is primarily seen as one of the future paths of the area. The idea is to provide a platform for developing internationally competitive technological solutions in the field of the bio and circular economy. In the long-term development, the prospects opened up by the utilization of industrial internet have been identified by the ECO3 platform company. Digitalization also relates to infrastructure (fast fibre network connections, smart lighting, smart water, use of sensors etc.) and platforms, as ECO3 serves to match the demand and supply of business services and to develop technological solutions and create connections with niche markets. Within this, research institutions and universities, equipment manufacturers, process developers, and industries play an important part.

> Our challenge is that we still have not be able to make this digital breakthrough on a sufficient scale in the circular economy, where could leave the exchange of information to market to develop so that we would just gain the growth of businesses through this kind of market platform. Many have been initiated but . . . everything has its functional challenges. We have investigated our own platform and tried [it] and noticed how vulnerable it is. It is thus the kind of limiting factor at the moment that we have to take a digital leap in circular economy faster than we [do] at the moment. It requires quite a lot of insightfulness also from the point of view of national government, regarding who owns the platform. It cannot be some minor player like Verte, or any region, but we really need in this case

also the Finnish [national] scale solution. They would then benefit our regions, of course. (Interview 5 Representative of the ECO3 platform company)

Regarding the national scale, The Finnish Innovation Fund Sitra has had a significant impact on the national agenda. The national road map to a circular economy was drawn up under its leadership in 2016. Digitalization is on Sitra's agenda, which has had a direct impact on local development (see Sitra on circular economy at https://www.sitra.fi/en/topics/a-circular-economy/ (accessed on 20 March 2023)). Another example of a state-level solution is Materiaalitori or Marketplace for Materials (https://www.materiaalitori.fi/ (accessed on 20 March 2023)), a platform that facilitates the reuse of waste, production side streams and surplus materials, and recycled parts by bringing those who produce them and those who are able to generate value from them into the same forum. The service is owned by the Ministry of Environment and run by Motiva Ltd. (https://www.motiva.fi/en (accessed on 20 March 2023)). The latter is a state-owned company with an aim to promote, develop, and scale-up solutions for sustainable development together with the public and private sectors. It aims to promote smart-green transition by combining multidisciplinary expertise with digitalization.

Overall, it seems that the urban circular economy transition is more green than smart, even if digitality is identified as an area with considerable potential in terms of its impact on both the environment and the economy. In the academic literature, the role of IoT and AI have been identified as key enablers of green transition, but in the cities and regions, there are many barriers to the full utilization of such solutions [89]. While such barriers usually include psychological, policy, financial, and managerial issues, it seems that in the case of the Tampere urban region, the lack of critical mass is an obvious hindrance in the technology deployment side of the smart-green transition. This shows that rather than envisioning a digitally connected ecosystem and integrated urban cycles with industrial symbiosis at their heart, the focus is pragmatically on digital production, in which attention is paid to optimizing the use of energy and raw materials at the company level. Another observation is that the main solutions seem to be platforms and applications, which require a critical mass of users to become feasible. It remains to be seen how successful the municipalities of the Tampere urban region will be on this front.

8.4. The Modes of Governance and Circular City Development

Let us next discuss how each basic mode of governance manifests in municipalities' involvement in the promotion of circular city development. While the aim of designing effective CE policies drives for innovating the forms of public governance, there are also other drivers, such as breaking the silo mentality and the willingness to utilize private capital and organizational capacity by building public-private partnerships [141], which push governments towards new modes of governances that go beyond conventional hierarchical structures. Such tendencies are visible in how the CE is governed, especially in Western countries, Finland included [145]. Such changes are manifested in how various modes of governance are applied in the municipalities of the Tampere urban region.

To exemplify the four forms of public governance, a typical case of hierarchical governance is regulation, a conventional form of governance by market is public procurement, a typical form of network governance is loosely organized collaboration, within which organizations share resources or knowledge, and governance by communities involves, in its characteristic form, volunteering. Let us next consider how these modes of governance relate to the promotion of CE development in the Tampere urban region.

To start with, *hierarchical governance* forms the basis of the representative system of government. In terms of relationality, the hierarchy is based on public authority and defined jurisdictions. Regarding the foundations of spatiality and digitality, the hierarchy shows, as a rule, a tendency to favor local solutions and pay special attention to local assets [25]. And, at least theoretically speaking, transactions related to high asset specificity favors the hierarchical governance mechanisms [146].

In the local public governance, the local culture and administrative traditions have a vital role to play. In the Nordic context, the administrative culture that utilizes hierarchy as a mode of governance is consensual. Thus, the well-developed hierarchical structures, in which the political and administrative sides work together, are used to mold the idea of circularity into the form that contributes to consensus building, reminiscent of the ideological local state apparatus. In such a case, dissident voices and challenging views are tendentiously ignored, even if the circularity issue itself is complex and the design of policy responses is far from simple, as exemplified by the claim that, according to the second law of thermodynamics, "nothing is 100% circular", which sets certain natural limits to the circular economy [34,39,142,147,148]; the need to consider both mitigation and adaptation as major strategic approaches to climate change, which has a connection with the legitimation of the CE policy [149,150]; and with the observation that outcomes of CE policy actions vary significantly depending on the CE value source [151,152]. Tension may therefore rise between the predetermined CE framework with commonly accepted fixed goals and the critical views that are essential in the making of the evidence-based policy [153–155].

Consensus orientation among major political and economic players creates a resemblance to regime and administrative politics. A particular feature of the CE policy agenda is that it does not rise from the everyday lives of citizens, but rather from research institutions, activist groups, and progressive public institutions, which appeal to businesses and media to join their efforts. This explains the "soft" hegemony involved—i.e., the use of ideational power that through persuasion creates consent [156]—and the ultimate reliance on a hierarchical mode of governance that is supplemented by stakeholder involvement, collaboration, and the utilization of networks, which creates a so-called heterarchical form of governance [157,158]. It uses "soft or light means of exerting pressure" towards local businesses in the pursuit of gradually transforming linear business models into circular models (Interview 9 Representative of Ekokumppanit Ltd. of Tampere City Group).

In practical terms, the hierarchical mode of governance is seen in goal setting and plans, such as the Carbon Neutral Tampere 2030 Roadmap (Doc2) and The Circular Economy Plan of the city of Tampere (Doc3), in legal provisions and regulatory functions, and in various functions and services provided by the local governments. Regarding the material side of circularity, special attention is usually paid to waste management, in which the role of legislation, regulatory guidance, and control measures reflect the hierarchical governance. However, it has become equally important to build a broader local CE agenda that directs attention to such functions as town planning, construction, and municipal property management, in which local governments' statutory roles and responsibilities can be directly linked to urban metabolism. For this reason, the city of Tampere has focused The Circular Economy Plan (Doc3) on activities that are within its direct control.

Governance by markets implies a paradigm shift, as rather than correcting market failures or public service production relying solely on in-house solutions, the public sector argues for the utilization of the market mechanism in pursuit of the public interest. This approach favors deregulation, marketization, and managerialism, which are part of the New Public Management doctrine. In terms of relationality, it increases efficiency and effectiveness, but also transaction costs, complexity, and risks, while in terms of spatiality and digitality, it is a source of diversification and expansion. In the Tampere urban region, it is manifested in the form of corporatization and the use of intermediaries, as well as in integrating the principles of the circular economy into public procurement.

The combination of the hierarchical and market logics easily becomes a target of a stereotypical macro-theoretically oriented political economy analysis of the CE. For example, as crystallized by Kębłowski and others [61], "the CE debate is biased toward technology-driven industrial change, while bracketing broader socio-political interests". In the case of the Tampere urban region, this appears to be a double-edged sword. Businesses are focused on not because of technology-driven industrial change per se, let alone because of neoliberal sentiment, but rather because of the necessity of their involvement. Thus,

there may be a kind of "urban sustainability fix" in place, with a certain degree of selectivity in terms of the incorporation of ecological goals in urban governance, as proposed by Kębłowski and others [61]; however, in the Tampere urban region, it seems to reflect a progressive sustainability-oriented agenda rather than the interests of the greenwashed capital accumulation.

Network governance together with similar forms of governance, such as ecosystems, platforms, and partnerships, have their concrete expressions in various forms of stakeholder involvement in CE-related activities and in the local governments' involvement in the CE networks and platforms in the region. In terms of relationality, it increases plurality and interactions, which in turn increase the importance of social elements like trust and reciprocity. In terms of spatiality, it implies sharing, and of digitality, it has a clear tendency to facilitate interaction on digital platforms. Network governance, which is usually associated with New Public Governance, seems to be a kind of framing governance model due to the premises of the promotion of urban circularity, for a CE cannot be dictated effectively by the city government within the current institutional framework. This requires the commitments of stakeholders, particularly businesses, and their internalized involvement in the promotion of the CE, which tend to increase the complexity of the governance scene [141]. This reflects the cooperative attitude of major institutional actors, most notably in the relationship between government and business, which is one of the preconditions for the receptivity to the form of network governance characteristic of Finland and other Nordic countries [141,159]. In this area in particular, ecosystem thinking is increasing, as seen in the activities of Business Tampere, as it is a convenient way of incorporating the CE agenda into business development. Another manifestation of the same trend is the emergence of development and research projects, which explicitly aim at establishing or developing networks or ecosystems, of which a representative example is The Circular Economy RDI Network in Civil Engineering established collaboratively by Tampere University of Applied Sciences and Tampere University (see RATKI Project at https://projects.tuni.fi/ratki/in-english/ (accessed on 20 March 2023)).

Lastly, *community governance* has a minor role in the current institutionally oriented agenda. It can be seen, however, in The Circular Economy Plan of the city of Tampere in the form of sharing, which has a rather vague role in this setting (Doc3). This is in line with Cramer's description of the government–NGO relationship in Finland, which is cooperative but is also occasionally antagonistic [141].

How do the previously described modes of governance affect the preconditions, design, and implementation of local CE policy? It seems that the weight given to each mode of governance in promoting the CE reflects the approach to CE policy, i.e., different modes of governance tend to have different impacts on the roles institutional players have in agenda setting and stakeholder involvement. Furthermore, as the modes of governance have evolved over time and made the multimodality of governance a reality, it has caused the increase in the complexity of the CE policy scene. As pointed out by Wijkman [142] (p. 43), cities have the ability to incorporate environmental externalities into business and consumer activities within their field of competence. Yet, they also have a direct impact on circularity, especially through areas relating to infrastructure services: "Cities have the authority to decide on a lot of things related to city planning, energy and material use, infrastructure, building and construction, mobility and transport and waste management". Taken this into account, Table 3 illustrates the practical outcome of the previously discussed multimodality by highlighting how three basic categories of governance are applied in land use planning, the construction sector, and the built environment in the pursuit of a local CE in the case of the city of Tampere.

Table 3. The forms of governance and their application to selected infrastructure services in the city of Tampere. Source: Adopted from [160].

Mode of Governance	Field of Municipal Engineering	Examples
Governance by hierarchy	Land use planning	Municipal zoning: infilling, eco-industrial parks, recycling sites, herb gardens for urban farming
	Property management	Optimization of city's spaces, improvements of occupancy rates of facilities, shared use of facilities
	Building demolition	Requirements concerning demolition reviews
Governance by markets	Municipal plots	CE-based terms of sales or lease of land: requirements to use recycled materials in new buildings
	Property management	Public procurement of renovations: rating bids using CE criteria
	Construction	Enabling CE type of construction
	Management of land masses	Material bank
	Building demolition	Demolition projects and reuse of rubble on market terms
Governance by networks, partnerships, platforms, and communities	Property management	Space 24/7 platform
	Construction	CE guidance for enterprises, support for CE education
	Management of land masses	Eco-park industrial providing space for land masses, monitoring of land masses by the digital platform
	Building demolition	Enhancing public-private collaboration in order to utilize rubble

Overall, the parallel use of different modes of governance forms a complex setting that requires a certain degree of integration in order to enable a full utilization of the capacity of local government, businesses, stakeholders, and users in the strive for CE policy and related policy goals, such as carbon neutrality. This reflects a belief, as noted by Olsen [161], that pluralistic societies with a highly developed division of labor and sophisticated institutional landscape rely on several modes of governance, of which Nordic cities like Tampere and Nokia are prime examples. The layered structure of the modes of governance is likely to create novel reconfigurations. This brings an integrated or fused multimodality into the picture, which will be briefly elaborated on in the next section.

9. Discussion

9.1. Reflections on the Case of Tampere Urban Region

The urban regions in the Nordic welfare societies have many favorable preconditions for a smart-green transition. However, the attainment of the goals of such a complex transition, which is likely to take decades, has its local and contextual conditions, of which relationality, spatiality, and digitality have been addressed in this article. Even if the relational aspect is largely an implicit factor behind the development efforts in the Tampere urban region, in the given context, it can be identified in the emphasis on collaboration over competition and communicative over instrumental rationality [162]. This observation is in line with the case of Finland, which is categorized as being a consensus-oriented and pluralistic society in which collective interests prevail [141].

Another factor worth emphasizing is that the circular economy shows signs of a hegemonic discourse, a shared social-ecological imaginary, and consensual policy making that have gained support from the national government, as well as from the EU and international organizations. While there are, at times, reactions against such consensual, unquestioned, and sedimented thinking, the institutionalized hegemonic tendencies soften the critical views on the CE [163,164].

A critical integrating factor in such a transition is the sophistication and effectiveness of urban-regional governance. Neither the mode of governance nor the public governance paradigm determines the policy choices regarding smart-green transition per se, but they nevertheless give a hint of how such a policy issue was conceptualized around the relational locus of local governance (on public governance paradigms, see [165]). The relational side of the smart-green transition in the Tampere urban region is fragmentary, which is, to a degree, in line with the ambiguity caused by the hybridization of urban governance that characterizes the local governance in Finland and other Nordic countries [166].

Spatiality as an essential aspect of 'the urban' has a significant role in anchoring circularity through designated areas or enclaves that can be used in scaling-up CE solutions. The related tendency to secure, that the added value created within a circular economy stays in the area, is eased by the regional perspective and progressive intermediary organizations, as clearly seen in the cases of the inter-municipal waste management company of the Tampere Region, Business Tampere, and Verte Ltd.

An interesting fact in terms of spatiality is that municipalities with older landfills and related operations seem to have had a head start in developing circularity and identifying the opportunities created by an emerging circular economy, especially after establishing progressive intermediary organizations to promote area development, stakeholder involvement, bio and circular clusters, and circular economy platforms. The symbolic capital attached to locations, as in the case with ECO3, brings an additional element in the development of urban circularity. It enables the inclusion of a circular district brand in the place brand architecture of a municipality, the most illuminating case being the city of Nokia. The same also applies, to a degree, to regional branding, as local actors can present themselves as a part of the progressive circular region (on the regional dimension of CE policy, see [167]).

While the Finnish development model harnesses the local capacity, primarily in order to follow its "circular success story" model that reflects high awareness, institutional lead, global connectedness, and CE-dominated business, there are also parallel developments rooted in local realities that reflect "local circles" as the future image of the CE, reflecting local responsibility and initiatives, a mixed CE and linear economy, and start-up-dominated CE innovation [8,168]. In Finland, there has been some limitations regarding CE research on circular business models, and more so on urban circularity [169], though it is difficult to say what its impact has been on the CE policies and performance.

In the case of the Tampere urban region, the twin transition seems to be more green than smart if it is assessed against the level of digital smartness of circularity. However, the huge opportunities associated with digitalization imply that technological innovations and smart solutions will continue to play a role in the green transition. It is not necessarily only the lack of a critical mass that appears as an inhibiting factor regarding the smartness of the green transition, but also the complex nature of circular city development, which hints at the difficulty in producing a high level of circulation of urban streams that would match with the theoretical idea of the optimal circular city [170]. This is the reason why larger regions are assumed to be the most suitable units for building a functional CE [167]. It may also explain why the approach in the Tampere urban region appears to be leaning towards small-scale innovations developed within a start-up scene. This indicates an incremental route to circularity, but nevertheless plants the seeds of potentially disruptive innovations in circular businesses.

9.2. Towards Hybrid Governance?

The previous discussion implies that the choice of the mode of governance affects CE policies and has obvious ideological underpinnings. Interestingly, when the utilization of various modes of governance proliferates, it inherently reshapes the entire governance field. An issue worth further discussion is to what extent and how such a field is integrated in order to avoid fragmentation, which may eventually become detrimental to the implementation of CE policy.

The concept of integration has a multi-dimensional nature, as we may integrate sectors, settings, processes, issues, and producers [171]. What makes an urban smart-green transition challenging in this respect is its dual nature, with both sectoral and spatial sides. Integration is evidently a feasible approach when discussing governance at the ecosystem level [172], which, however, easily omits those elements from the picture that do not confine to the narrowly defined ecosystem—in our case, the bio and circular economy ecosystem in the Tampere urban region. If we alternatively shift the discussion towards collaborative governance regimes [171], there is a tendency to emphasize the administrative and institutional aspects of the setting. This hints at the need for an integrative approach: bringing stakeholders together; taking into account the local drivers of the smart-green transition in the agenda setting; and showing leadership in the process. To put such a relationality into its urban-regional context, spatiality and urban conditions and structures should be taken into account as elements that condition and mingle with relationality [115,173].

The discussion about the urban and regional governance of circularity is still rather limited [27,174,175]. Our interest is directed towards the modes of governance and their connections implied by relationality and its multimodality, which has a connection with hybridity [27,176]. Hybridity addresses the inter-sectoral interplay within the setting characterized by parallel institutional logics. It reflects a natural condition of a polycentric society with a high degree of dynamism, pointing to the local actors' strive for a greater good [176,177]. This is the issue addressed by Christensen [27] in the context of the circular economy, his focus being on the use of assets, ownership, and regulation, as well as various forms of collaboration. His case analyses emphasize the role of the local government as a change agent and as a facilitator of circular transformation. Such findings are in line with the development of the CE in the Tampere urban region.

The previous observations reveal an interesting feature of hybrid governance. Namely, in order to be able to accurately portray the instances of hybrid governance, there is a need to go beyond hybrid organizations and institutions, or 'hybrids' as units, if we wish to understand the processual nature of the relationality of public governance [177]. Moreover, the temporal and processual dimensions of hybridity appear to be important in such settings, as oftentimes the various logics of governance appear successively or in rotation in loosely integrated governance processes, as in the case of the Kissanmaa plot handover process in Tampere, in which the logics of public hierarchies, markets, networks and partnerships, and private hierarchies rotated or became dynamically assembled. It allowed the city government to permeate the CE criteria into construction and to utilize the creativity of private companies while doing so. Such observations make it obvious that the early structural development of hybridization, which revolved around the formation of hybrid intermediaries in particular, are being supplemented by processual hybrids that enable dynamic and flexible governance solutions with the local government having multiple roles and being able to utilize various institutional logics as dynamic assemblages [178].

Lastly, as pointed out by Nylén and others [176], when an ambiguous and "idealized" policy agenda confronts material realities, its implementation becomes naturally dispersed, and centrifugal tendencies are likely to emerge. This does not imply that the CE policy itself is irrelevant or meaningless. Rather, the agenda maintains its relevance, provided it is consistently kept focused, fact-based, beneficial, and incorruptible. In addition, when the actualization of the idea moves closer to implementation, the more pressing the hybrid reality of the societal setup becomes, implying that the CE practices must fit into the institutionally and socio-culturally embedded micro-contexts [141,176]. This is visible in the Tampere urban region, which reflects the cultural and institutional peculiarities of the Nordic model.

9.3. Remarks on Smart Circular City Literature

How does the governance of the urban smart-green transition in the Tampere urban region reflect the research-based view of the development of smart circular cities? The current discussion of CCs is gradually taking shape, with the European Union (EU) as

its primary macro-regional reference. Its aim has mainly been to shed light on the strategies and frameworks of, and approaches to, the development of CCs. Let us take a few representative examples of the current discussion.

Boeri and others [52] emphasize that in the context of the increased complexity of urban growth and its connection with the environment, there is an obvious need for innovative approaches to close the resource loops as envisioned by the EU, including the systemic connection between urban, peri-urban, and rural areas. The key methods of achieving this include engaging communities in the loops of proximity and facilitating entrepreneurs and stakeholders in the co-creation of a circular economy. One particular identified challenge is to overcome the narrow business focus, which still seems to dominate local approaches, while there is much to learn about how a circular economy creates economic, social, and environmental resilience in cities. In relational terms, cities' approaches should be anchored in *place-specific and multi-scalar transition relations* [94]. This is reflected in the institutional and aspirational features of the municipalities of the Tampere urban region, which draw inspiration from and benchmark their performance targets against the national and EU frameworks and policies.

There are a few philosophical issues that resonate with the SCC discourse. One of them is how to understand the urban CE and what the relationship is between circularity, as a part of ecological systems, and the economy, especially in its linear mode. Genovese and Pansera [179] claim that the apolitical and technocratic framing is one of the biggest problems in this respect, which has given an impulse to generate alternative conceptualizations, of which one is to connect the CE with *convivial technology* [180]. The latter refers to technology that is defined by its telos, or its ability to facilitate and enable the largest possible fulfilment of people's individuality, creativity, and solidarity, while at the same time causing a minimal ecological net burden to the ecosphere. Such an idea of technology is in line with the degrowth agenda and points to its obvious deviation from the concept of technology in the smart city discourse. The adoption of such ideas does not happen at the grassroots level until the new smart-green transformation has created the spirit that led to the previous technological revolutions: our shared desire to strive for a new way of living that reflects our ideal of a good life. It may be that smart-green development, which started as a vague idea, is gaining ground and becoming "the aspirational good life of our current technological paradigm," as promoted by the EU [181].

The digitalization of urban metabolism or circularity offers huge potential, especially in the form of analyzing and utilizing data on the flows of resources. Circularity of resources implies the relevance of another reform principle, namely *integration*, which, in addition to integrating digital technologies into resource flows, serves as a generic means of optimizing the circularity of urban metabolic flows [65]. The concept of a SCC, or various versions of it, has been developed to make cities sustainable by applying smart solutions, including smart data and smart logistics. For example, a smart and open 3D digital spatial city model has been sketched to improve the facilitation of the data-driven collection and reuse of construction and demolition waste, as well as the optimization of the transport of construction materials through the city [182]. In this respect, the Tampere urban region faces challenges due to the factors associated with the previously mentioned critical mass of users, providers, and developers. This urges us to consider what the integration of digital technologies in the context of urban circularity factually means, what are its preconditions, and what benefits such an integration is supposed to bring about. Such questions are still insufficiently addressed on the smart circular city agenda in the Tampere urban region.

Lastly, most of the academic discussions about smart circular cities revolve around ecosystems, clusters, and industries, or various sectors, such as water, waste, energy, and food. The usual storyline goes from a linear to a circular economy, with smartness bringing forth an important enabling aspect of such a transition. The barriers of this transition—including ownership issues, lack of government support, administrative burden, regulatory problems, the lack of integration among supply chain partners—are often explicitly discussed as an indication of the underlying challenges of CE policy and practices. The

macro-level concept of a Smart and Sustainable Circular Economy (SSCE) has been introduced to address such matters, highlighting the interrelatedness of technology, producers and consumers, and public policy [183]. Another similar discussion revolves around the connectedness of circularity, smartness, industry 4.0, and energy [184], and their relationship with resilience [185]. While smartness is discussed in waste management in the context of small-scale innovations, such as using sensors in bins, it has also been conceptualized within a broader framework, including complex policy and integrated planning issues. On the positive side of the picture, smart sustainable cities are associated with development that takes us towards industrial symbiosis, regenerative systems, and the full-scale creation of new patterns linking innovation and entrepreneurship for economic growth [186]. Even if this aspect is not particularly pronounced in how the municipalities of the Tampere urban region promote the CE, the role of business itself is deemed important, and there is a clear tendency to strike a balance between a progressive agenda and the conditions of businesses in order to guarantee the feasibility of the implementation of local CE policies.

10. Conclusions

This article has outlined the governance of the smart-green transition towards a circular city. We attempted to find an answer to the following question: how do the modes of governance relate to the social, spatial, and digital aspects of the smart-green transition of cities in the advanced welfare society context? While this discussion is theoretically oriented, the theoretical ideas are exemplified by making references to real-life developments in the Tampere urban region, Finland.

Our discussion shows that *relationality* in the given context is dominated by a persuasive public sector framework and managerial organization principles applied to the organization of critical activities in the CE, such as regional waste management. While the city governments as a rule focus, as a first instance, on the actions within their direct control, they also tend to reach out to a wide range of stakeholders, of which the primary target group is construction and manufacturing companies. This is visible in the cases of Tampere and Nokia. *Spatiality* is not a particularly pronounced aspect of the CE agenda, even though the formation of eco-industrial parks, such as ECO3 in the city of Nokia, and residential developments, such as Hiedanranta in Tampere, are particularly pertinent manifestations of the spatially determined actions related to the CE. In terms of smartness, this transition is more green than smart. Both the policy documents and interviews indicate that *digitality* is a somewhat underdeveloped topic in this agenda. While its potential has been acknowledged among the key institutional players of the Tampere urban region, its realization requires nationally coordinated actions and a critical mass of producers, developers, knowledge creators, and users in the urban-regional circular ecosystem. In this respect, the Tampere urban region, as well as the wider Tampere Region, possesses some deficiencies typical to small-country cases.

Regarding *public governance*, various modes of governance are utilized in promoting the urban-regional CE in the Tampere urban region. There is a strong tendency towards regionalization, which decreases tension between local authorities and improves the chances of creating synergies. The parallel use of various institutional logics and different modes of governance seems to require hybrid metagovernance, which may in due course emerge as a defining feature of the democratic local public governance in the Tampere urban region. At present, a key role is played by publicly owned companies, such as regional waste management and business development companies, which mediate the public and private spheres. In summary, the governance of the CE ecosystem in the Tampere urban region, even if it is rooted in hierarchical arrangements in terms of democratic governance and bureaucratic practices, forms a hybrid reality that has been in the making for a few decades.

The weight given to different *modes of governance* in promoting a CE indicates different frameworks within which CE activities have been perceived. Different modes of governance tend to have an impact on institutional players' roles in agenda setting and on determining how political parties, trade unions, local businesses, associations, households,

and other stakeholders are involved in the design and implementation of CE policy. As these modes of governance have evolved over time and caused the strengthening of the multimodality and hybridity, it has increased the complexity of CE policy, broadened the CE agenda, and changed the primary role of the local government from an authority to a facilitator and an enabler. The governance model, while obviously developing towards hybrid governance, seems to have evolved from structurally determined hybridity, as reflected in the formation of intermediaries, towards processual hybridity, in which different institutional logics are utilized consecutively—paradigmatically from public hierarchy to market to networks/partnership to private hierarchy—in situationally decided dynamic assemblages.

The limitations of this article primarily relate to the theory-driven exemplary case analysis. It implies that there is a need for broader and deeper empirical evidence through both quantitative and qualitative analyses. Moreover, as this article provided a schematic view of an interplay between three critical factors and local CE governance, these three categories—relationality, spatiality, and digitality—should be further elaborated on, and more importantly, the analysis of their interconnectedness and contextual nature should be deepened. Lastly, a topic that should be further elaborated on is the social ontology of hybrid governance. The real-life experiences of CE-oriented governance in the Tampere urban region indicate that a more sophisticated understanding of the processual aspect of hybrid governance would sharpen our view of the utilization and assemblages of different institutional logics and further their ability to integrate the CE into business models and urban development.

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Appendix A. Interviews

Interviews were conducted by Akseli Tiensuu in March-April 2022 (interviews 1 to 7) and Aku Puskala, Markus Laine and Akseli Tiensuu in June 2023 (interviews 8 to 9). Below is the list of organizations whose representatives were interviewed.

Interview 1. Economic Development unit of the city of Nokia. The city of Nokia is a municipality with some 35,000 inhabitants in Tampere urban region. It is the host city of ECO3 bio and circular economy business park. (Interviewed by Akseli Tiensuu.)

Interview 2. Urban Development unit of the city of Nokia. The city of Nokia is a municipality with some 35,000 inhabitants in Tampere urban region. (Interviewed by Akseli Tiensuu.)

Interview 3. The Waste Management Company of Tampere Region (Pirkanmaan Jätehuolto Oy in Finnish). It is an inter-municipal corporation owned by 17 municipalities. It provides services to some 454,000 inhabitants of Tampere Region, covering waste management services required by the Finnish law. (Interviewed by Akseli Tiensuu.)

Interview 4. Business Tampere (Tampere Region Economic Development Agency Business Tampere). Business Tampere is a regional economic development company that serves eight municipalities in Tampere urban region, i.e., Tampere, Kangasala, Lempäälä, Nokia, Orivesi, Pirkkala, Vesilahti, and Ylöjärvi. As an economic area, it is in Finland only second to capital region, and known as one of the growth centers of the country. (Interviewed by Akseli Tiensuu.)

Interview 5. Verte Ltd. Verte Ltd. is the ECO3 platform company and a development company of the city of Nokia. It concentrates on bio and circular economy and the promotion of ECO3 and the larger Kolmenkulma eco-industrial park. Kolmenkulma is a large cleantech business area focused on logistics, production, and services at the intersection of three municipalities, those of Tampere, Ylöjärvi, and Nokia. (Interviewed by Akseli Tiensuu.)

Interview 6. A private company that operates at ECO3 bio- and circular economy business park located in Nokia. (Interviewed by Akseli Tiensuu.)

Interview 7. Tampere University. Tampere University is a multidisciplinary university located in the city of Tampere. With some 21,000 students and about 4000 staff members it is the second largest university in Finland. It brings together research and education in various disciplines that revolve around technology, health, and society. (Interviewed by Akseli Tiensuu.)

Interview 8. Plot team of the city of Tampere. The city of Tampere is the largest city of the Tampere Region with some 250,000 inhabitants. (Interviewed by Aku Puskala and Markus Laine.)

Interview 9. Ekokumppanit Ltd. is a municipally owned company with a mission to promote sustainable development. It is a part of the Tampere City Group, which includes organizations that are fully or partly owned by the city of Tampere. The city of Tampere is the largest city of the Tampere Region with some 250,000 inhabitants. (Interviewed by Aku Puskala and Akseli Tiensuu.)

Appendix B. Policy Documents

Doc1. Economic development strategy of Tampere city region, retrieved 13 January 2023, from https://businesstampere.com/economic-development-strategy-of-the-tampere-city-region/ (accessed on 20 March 2023).

Doc2. Carbon Neutral Tampere 2030 Roadmap. Tampere City Board 31 August 2020, retrieved 13 January 2023, from https://www.tampere.fi/sites/default/files/2022-06/Carbon_Neutral_Tampere_2030_Roadmap.pdf (accessed on 20 March 2023).

Doc3. Tampereen kaupungin kiertotaloussuunnitelma [The Circular Economy Plan of the City of Tampere]. Raportti 14.4.2022. AFRY Finland Oy. Retrieved 13 January 2023, from https://www.tampere.fi/sites/default/files/2022-09/tampereen_kiertotaloussuunnitelma_2022.pdf (accessed on 20 March 2023).

Doc4. The City of Action: Tampere City Strategy 2030. Retrieved 13 January 2023, from https://www.tampere.fi/sites/default/files/2022-06/The%20Tampere%20City%20Strategy%202030_0.pdf (accessed on 20 March 2023).

Doc5. City of Sustainable Action: The Voluntary Local Review of the UN Sustainable Development Goals in Tampere 2022. Retrieved 13 January 2023, from https://www.tampere.fi/sites/default/files/2022-06/Tampere_FI_VLR_%20City_of_Sustainable_Action_2022.pdf (accessed on 20 March 2023).

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